Engineering Library
AUG 8 1921
IN TWO SECTIONS—SECTION ONE

MECHANICAL ENGINEERING

INCLUDING THE ENGINEERING INDEX

IN THIS NUMBER

THE PRESENT TREND OF TURBINE DEVELOPMENT
By Lewis F. Moody, Consulting Engineer

SPEED REGULATION OF THE HYDRAULIC TURBINE
By R. D. Johnson, Consulting Engineer

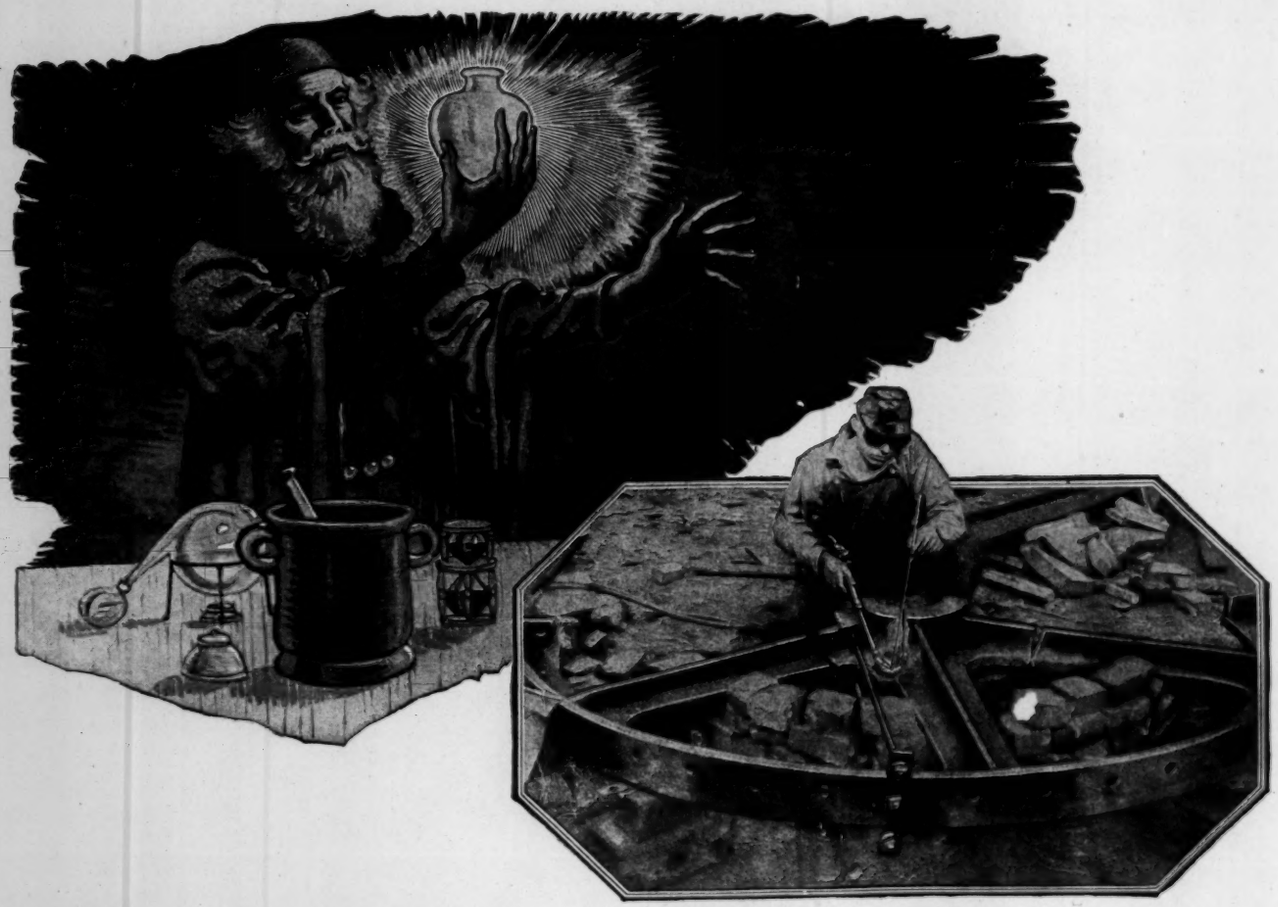
MEASURING WATER FLOW FOR POWER PURPOSES
By Norman R. Gibson, Hydraulic Engineer

PRINCIPLES OF INDUSTRIAL PHILOSOPHY
By Walter N. Polakov, Consulting Engineer

The Opportunity of the Engineer—A Place for Non-Scientific Management—The Engineer Cabinet Member

APRIL 1921

THE MONTHLY JOURNAL PUBLISHED BY THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS



The age-old dream of the alchemist is realized because of Linde

THROUGH countless centuries man dreamed of transmuting the baser metals into gold. Patiently, laboriously, often consecrating their very lives to the work, the Alchemists of old toiled on toward their elusive goal.

As late as 1873 James Price, the last of the Alchemists, sought death by his own hand rather than acknowledge the failure of his experiments.

Linde Engineers of to-day have made this dream of by-gone ages come true.

By producing uniformly pure oxygen in industrial volume, they have made it possible for oxy-acetylene welders and cutters to reclaim thousands of tons of metal machinery annually—turning base metal into gold—a saving in money far in excess of any vision of wealth dreamed of by ancient philosophers.

And Linde does more than supply oxygen of absolutely uniform purity. Thanks to a chain of twenty-nine plants and forty-six warehouses it delivers Linde Oxygen when and where it is wanted in any volume.

THE LINDE AIR PRODUCTS COMPANY
Carbide and Carbon Building, 30 East 42nd Street, New York
Balfour Building, San Francisco

THE LARGEST PRODUCER OF OXYGEN IN THE WORLD

L-500-21

Mechanical Engineering

The Monthly Journal Published by

The American Society of Mechanical Engineers

Publication Office, 207 Church Street, Easton, Pa. Editorial and Advertising Departments at the Headquarters of the Society, 29 West Thirty-ninth Street, New York

VOLUME 43 APRIL, 1921 NUMBER 4

TABLE OF CONTENTS

The Present Trend of Turbine Development, L. F. Moody ... 235
Speed Regulation of the Hydraulic Turbine, R. D. Johnson ... 245
Measuring Water Flow for Power Purposes, N. R. Gibson ... 247
Principles of Industrial Philosophy, W. N. Polakov ... 249
Locomotives and Locomotive Terminals ... 255
Survey of Engineering Progress ... 259
Properties of Steam—Short Abstracts of the Month.
Engineering Research ... 273
Correspondence ... 275
Editorial Notes ... 280
The Opportunity of the Engineer—A Place for Non-Scientific Management—The Engineer Cabinet Member—The Unstabilized Dollar and Efficient Management—San Francisco-New York Mail Delivery and the Railroads.
Material-Handling Problems of Ports ... 283
The Elimination of Waste in Industry ... 284
Reconsideration of Nolan Patent Office Bill Urged ... 285
Engineering and Industrial Standardization ... 286
News of Other Societies ... 287
Library Notes and Book Reviews ... 288
Engineering Index ... 289
A.S.M.E. Affairs (Section Two) ... 41–52
Advertising Section:
Display Advertisements ... 297–E1
Consulting Engineers ... 106
Classified Advertisements ... 113
Classified List of Mechanical Equipment ... 114
Alphabetical List of Advertisers ... 132

Price 50 Cents a Copy, $4.00 a Year: to Members and Affiliates, 40 Cents a Copy, $3.00 a Year. Postage to Canada, 50 Cents Additional; to Foreign Countries, $1.00 Additional. Changes of address should be sent to the Society Headquarters.

Entered as second-class matter at the Post Office at Easton, Pa., under the Act of March 3, 1879.
Acceptance for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized on January 17, 1921.
C 55. The Society as a body is not responsible for the statements of facts or opinions advanced in papers or discussions.

Contributors and Contributions

Philadelphia Hydroelectric Symposium

The present power requirements of the public utilities, railroads and industries of the United States may be more than satisfied by the potential water resources, less than twenty per cent of which have been developed. The necessity for fuel conservation and the power demand for proper industrial growth point to intensive hydroelectric development.

Lewis F. Moody

The utilization of the great water-power resources of the country forecasts a notable advance in the design and installation of hydraulic units. Sensing this step forward and desiring to assist, the Engineers' Club of Philadelphia with the Philadelphia Sections of the American Society of Civil Engineers, the American Institute of Electrical Engineers and The American Society of Mechanical Engineers held a Symposium on Hydroelectric Development and Distribution. Through the courteous coöperation of the Engineers' Club of Philadelphia we are able to reproduce three of the articles submitted at that symposium.

The Present Trend of Hydraulic Turbine Development, as presented by Lewis F. Moody, stresses the significant steps in turbine evolution and outlines certain hydraulic relations affecting its development. Mr. Moody's entire professional career has been devoted to hydraulic development—as engineer and consultant with the I. P. Morris Department of the William Cramp & Sons Ship & Engine Building Company since 1904, where he now holds the position of assistant to the vice-president. From 1908 to 1916 Mr. Moody was also professor of hydraulic engineering at Rensselaer Polytechnic Institute.

The contribution by Raymond D. Johnson on the Speed Regulation of Hydraulic Turbines points out the importance of the coöperation of all factors entering into the problem of speed regulation so that the turbine governor itself will accomplish its purpose. Mr. Johnson's engineering work has included the installation of power units at Niagara Falls and the design and construction at the plant at Shawenegan Falls.

Legal restrictions placed upon the diversion of water from the Niagara River render important the measurement of the quantity of water used in various power plants. The method described by Norman R. Gibson in his paper on Measuring Water Flow for Power Purposes is the one utilized at Niagara Falls. Mr. Gibson is hydraulic engineer of the Niagara Falls Power Company and his professional work has been in connection with power development at that place.

Gantt's Philosophy

The latter part of the life of Henry L. Gantt was marked by his realization that a philosophy of industrial management was being evolved. At the Annual Meeting session in memory of Mr. Gantt, his philosophy was outlined by Walter N. Polakov, an associate well fitted to record and interpret it. Mr. Polakov's paper brought out written discussion, not presented at the Annual Meeting, which sheds additional light on Mr. Gantt's life and work. Abstracts from this discussion are included with Mr. Polakov's paper in this issue.

Railroad Motive Power

The provision of additional motive power and the efficient utilization of locomotive terminals are important problems in railroad operation today. At the Railroad Session of the Annual Meeting the papers on these subjects by Messrs. Rink and Smith brought out considerable discussion from a number of valuable sources. In the treatment of old locomotives the application of improved devices was advocated, while in the utilization of terminals consideration was given to the factors that insure capacity and reliability of operation. The discussion is abstracted in this issue.

The Editorial Page

That the engineer is at the threshold of opportunity is now generally realized. Dexter S. Kimball, Dean of Engineering at Cornell, on the editorial page of this issue of Mechanical Engineering, presents in a logical way the steps of development that made the opportunity available. Dean Kimball's leadership in pointing the way has been recognized by his election as vice-president of The Federated American Engineering Societies.

Ralph E. Flanders, of the Jones & Lamson Machine Company, writing on the topic A Place for Unscientific Management, sounds a new note that at first seems discordant. Like some modern music, however, it resolves into harmony after repetition.

The importance to the engineering profession of Mr. Hoover's appointment to the Cabinet cannot be overestimated. Past-President Miller's comment on this event makes clear the responsibility to be borne by Mr. Hoover in showing the country that the engineer can serve the public in other than technical capacity.

Dr. Harlow S. Person, Managing Director of the Taylor Society, calls the attention of the engineer to the fact that one of his tools should be a correct knowledge of fundamental economic principles. His reference to Dr. Irving Fisher's speech at Springfield is of interest and value.

New Information About the Properties of Steam

Prof. H. L. Callendar's new treatise on the Properties of Steam and Thermodynamic Theory of Turbines is an important addition to the literature of the subject and presents the conclusions of the author derived from his extended experimental work. Professor Callendar's name has long been associated with fundamental data in this field and the review of his book from London *Engineering*, abstracted in the Survey of Engineering Progress, is worthy of careful reading.

A.S.M.E. SPRING MEETING

DAYTON, OHIO, MAY 21
Excursion to McCook Field

CHICAGO, MAY 23-26
Main Meeting with Technical Sessions and Excursions

ROCK ISLAND ARSENAL, MAY 27, 28
Inspection Trip, Ordnance Session

Further information is given in Section Two of this issue

MECHANICAL ENGINEERING

Volume 43 April, 1921 Number 4

The Present Trend of Turbine Development

A Brief Survey of Past History and Recent Progress, Together with a Discussion of Theoretical Problems Involved in the Hydraulics of the Modern High-Speed Turbine

By LEWIS F. MOODY,[1] PHILADELPHIA, PA.

IN order to gain some idea of the direction in which the development of the hydraulic turbine is tending, it is useful to consider the path by which the turbine has reached its present condition. There are a few phases of the turbine's evolution which are worth noting, and these will be briefly mentioned.

The early turbines, during the first half of the last century, were most frequently of the single-runner, vertical-shaft type, usually set in open flumes, and having, at the choice of the builder, outward-flow, axial-flow, or inward-flow runners. After about 1850 the turbine began to develop along more theoretical lines, and much highly creative work was done on it by such engineers as Howd, Swain and Francis in America and Fourneyron and Jonval in Europe.

As an example of the early turbine forms, Fig. 1 is given, showing one of the Geyelin-Jonval turbines built by the I. P. Morris Co. and installed at the Fairmount Water Works, Philadelphia, in 1860. The regulation was furnished by a cylinder gate at the discharge from the draft tube.

Upon the advent of electrical power, the turbine began to experience rapid evolution. The requirements for driving electrical generators immediately called for great increases in the capacities of turbine units, and also demanded increases in speed. The simple form of single-runner, vertical-shaft turbine, such as that of Fig. 1, began to receive elaboration. At first two runners, and then still more runners were placed on a single shaft, and the vertical arrangement of shaft was abandoned in favor of horizontal-shaft units, as many as eight runners sometimes being placed in a single turbine.

The demands for close regulation of speed in the development of electrical power led to the improvement of gate mechanisms, and this also produced complication. Instead of the early cylinder and register gates, wicket-gate or movable-guide-vane regulation was introduced, requiring a material increase in the number of moving parts and the amount of mechanism.

The increasing demands for large amounts of electrical energy caused a corresponding increase in the size of units, and this phase of development of the turbine has continued practically without interruption; and there are no indications that the peak has yet been reached. With the growth of unit capacities, the importance of the turbine and its engineering problems increased correspondingly. When the turbine had reached a size such that any interruption of a single unit's service, due to a breakdown, or to such troubles as blocking by trash or ice, would involve a loss of 10,000 or 20,000 hp., it no longer became desirable to install a low grade of machinery nor to place many of the working parts within the water passages where they would be inaccessible for inspection, lubrication, adjustment or repair. The direction of evolution then took the form of a return to a simpler machine, and it no longer became the style to place four or six runners in a flume, each runner having twenty or more separate movable guide vanes, with a large number of the parts of the mechanism for operating them entirely submerged.

One of the notable installations in which this direction of development was followed to its logical conclusion was that of the Appalachian Power Co., including two plants having turbines all of the same design, these turbines being of the vertical-shaft, single-runner type, installed in volute casings formed in the concrete substructure of the power house. The Appalachian turbines (Fig. 2) were completed in 1912, and were the forerunners of a large number of notable installations which have followed all of the principal features exemplified by the Appalachian turbines, including the use of a cast stay-vane ring or so-called "speed ring" set in the concrete to stay the upper and lower walls of the casing together and to support the superimposed structure, a thrust bearing located above the generator to carry the revolving weights, and operating mechanism of the outside type placed in an open turbine pit in an easily accessible position, actuated by a hydraulic cylinder placed just above the turbine head cover.

When turbines of this type are built in the enormous sizes which are being adopted today, there is little possibility of the turbine being subjected to enforced shutdowns due to any accidental cause, such as trash or ice lodging in the runner or guide vanes, and the ruggedness of the machine, due to its being composed of a small number of heavy parts, provides strong assurance of operation through many years of continuous service. All working parts are accessible for lubrication. The size of these turbines in itself makes them independent of most of the ordinary vicissitudes.

In most of the early turbines no draft tubes were provided, the outflow loss from the runner being limited to small values and no attempt being made to regain the energy of the discharge. Straight draft tubes were then introduced with the vertical single-runner turbines, but in the multiple-runner units the use of several draft tubes in a single tail-race chamber frequently interfered with the flow, often introducing a serious loss of head. In many units curved draft tubes were adopted, of quarter-turn or elbow form, and in horizontal-shaft units central discharge draft chests were used common to a pair of runners. The elbow type of draft tube, however, was inherently unsuited to handle a whirling discharge from the runner, such as exists in turbines of high specific speed at all gate openings, and at part gate in all turbines.

With the adoption of the single-runner, vertical-shaft turbine, it became possible to provide volute casings in which the velocity of flow could be definitely determined at every point and all sudden changes in direction or velocity avoided. With the recent introduction of draft tubes which are symmetrical about the turbine axis, and the elimination of the elbow form of passage, it is now possible to conduct the water from intake to discharge without disturbances or eddy formation at any point.

The same sort of progress has taken place in the design of the guide vanes and runner. From the simple radial- or axial-flow types of guides and runners, the effort toward increased speeds and capacities resulted in the adoption of so-called "mixed-flow" runners with complicated forms of wheel vanes, the water changing in direction from inward to axial or even to outward flow within the runner. A series of such runners of modern type is shown in Fig. 3, the largest being one of the runners for the Cedars Rapids Mfg. & Power Co., P. Q., Canada, and the largest ever built.

In turbines of extremely high specific speed, suited for use under very low heads and for small powers, where efficiencies can be sacrificed to some extent to secure a lower first cost, there has been a return to simpler runner types, including the purely diagonal-

[1] Consulting Engineer, I. P. Morris Department, The William Cramp & Sons Ship and Engine Building Company. Mem.Am.Soc.M.E.

Presented in Philadelphia Jan. 21, 1921, at a Symposium on Hydro-electric Development and Distribution, held under the auspices of the Engineers' Club of Philadelphia and the Philadelphia Sections of the American Society of Civil Engineers, the American Institute of Electrical Engineers and The American Society of Mechanical Engineers. Slightly condensed.

and the axial-flow runner. Such types seemed the logical development of the process of cutting back more and more the vanes of the high-speed "mixed-flow" runner. The trend of development has thus been toward a turbine in which there is a more gradual change in the direction of flow within the runner, the runner being closely related to the simpler types which preceded the mixed-flow runners. This change has simplified both the lines of flow and the forms of the runner vanes.

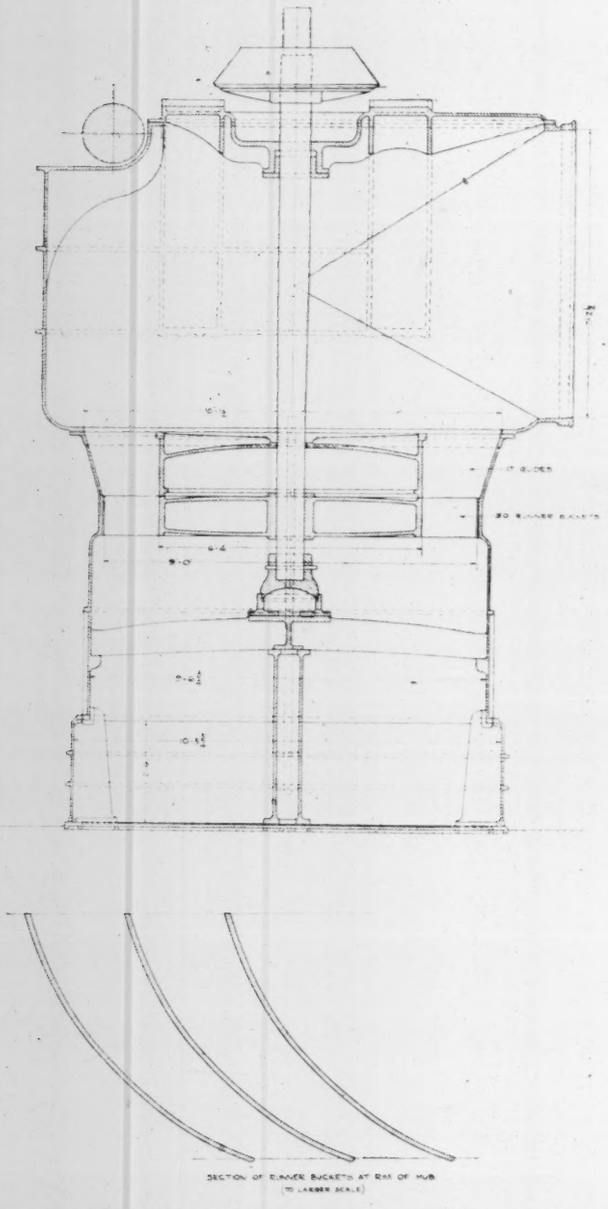


FIG. 1 I. P. MORRIS COMPANY TURBINE INSTALLED AT FAIRMOUNT WATER WORKS, PHILADELPHIA, IN 1860

With the adoption of the mixed-flow type of turbine, academic methods of calculating the hydraulic elements of the design became less and less applicable, and for a number of years hydraulic engineers have been greatly handicapped by the lack of any satisfactory method of rational design due to the complicated form which the turbine has assumed, together with the natural difficulties inherent in practically every hydraulic problem. Little enough is known about the flow of water in simple forms of stationary conduits, and there are many uncertainties involved in the complex problems of hydraulic machines having rotating water passages such as the turbine and centrifugal pump. The theories given in the textbooks are not of much help in designing the turbines of today.

The writer believes that it will be worth while to give attention to some of the theoretical problems involved in the hydraulics of the modern turbine. Without attempting to develop a complete theory, a few considerations or "speculations" will be explained below which have a bearing on the further development of the turbine. In particular, it will be of interest to look into the possibilities of securing further increases in specific speed without undue sacrifice of efficiency.

CHIEF ELEMENTS OF THE MODERN TURBINE

The chief elements of the turbine of the present, and probably of the immediate future, are:

1 A casing in which the water can approach the runner symmetrically with respect to the axis on all sides, without any obstructions or enforced abrupt changes of flow which would introduce eddies or unsymmetrical distribution of velocity. The spiral or volute casing meets these conditions, and in most cases is the most satisfactory form of intake. On account of the increase in the velocity of the water from a low value in the intake to a high value where it passes through the runner, the water passage must contract radially as it approaches the runner, and must subsequently expand again. The approach of the water to the runner therefore involves a radial component of flow toward the axis;

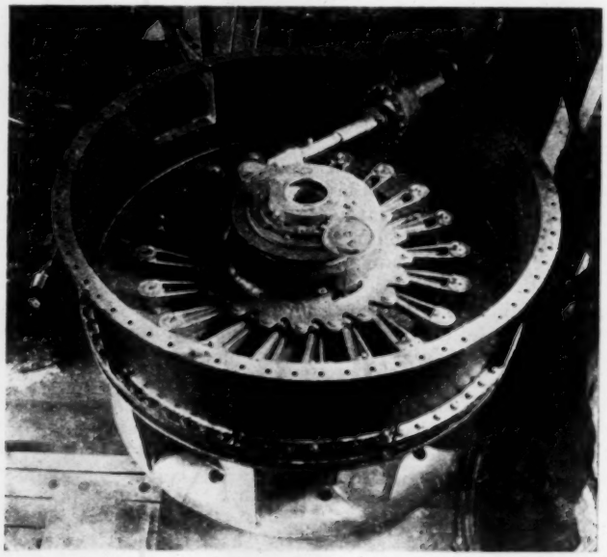


FIG. 2 TURBINE FOR APPALACHIAN POWER COMPANY, 1912, ERECTED IN SHOP

and by so-called "speed vanes" or stay vanes and by the movable guide vanes or gates the water is given increasing whirl or rotational components of motion about the axis as it nears the runner. After leaving the guide vanes the water continues to increase in velocity of whirl due to its closer approach to the axis, and at the same time it turns in the meridian plane and takes the axial direction either just before, during, or just after its passage through the runner.

2 A wide transition space is provided between guide vanes and wheel vanes, and in this space the water can come together in a continuous whirling mass before entering the runner. In a high-specific-speed turbine the water continues to contain whirl components of motion, but of somewhat reduced amount, after leaving the runner, even when the turbine is operating at its point of best efficiency.

3 After leaving the runner the water continues to flow as a whirling, axially advancing stream in a draft tube having a straight axis coincident with that of the turbine, and conical or flaring walls, this form of tube continuing, if what the writer believes to be the best practice is followed, until the velocity head has been reduced

to so low a value that no serious disturbance in the symmetry of flow through the turbine, or material loss of head, will be caused by diverting the flow into other directions or by finally discharging the water.

The turbine may be viewed as a water passage having walls which are surfaces of revolution and containing a continuous body of water which is both whirling and progressing with radial and axial velocity components, in which is placed a runner which develops torque by reducing, but not necessarily destroying, the whirl components of the flow. If a draft tube is used which is capable of regaining a considerable part of the energy due to the whirl components as well as that due to the axial components of the velocity of discharge from the runner, a result which can actually be secured, the "outflow loss" from the runner is reduced to a small fraction of that which enters into the usual textbook formulas.

The conditions of flow in the transition space in advance of the runner and in the draft tube, as well as the action of the water on the runner, can be usefully treated by means of the following method:

Consider the steady flow of water through a passage (Fig. 4) bounded by surfaces of revolution, and imagine the water to be given an initial whirl either by guide vanes or volute casing or equivalent means. Let us center our attention upon the annular space marked by double hatching. This ring is continually filled with water which is flowing in through its outer cylindrical surface of radius r_1 and out through its inner surface of radius r_2; and at any particular point in the space the velocity, pressure, etc., will be the same from instant to instant, since steady flow is being

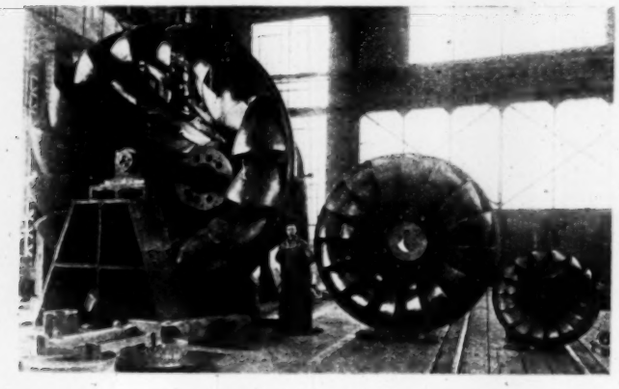


FIG. 3 MIXED-FLOW TURBINE RUNNERS OF MODERN TYPE

considered. There will therefore be no change with respect to time in the conditions within the ring-shaped space; so that this ring of water is in equilibrium, and is acted on by balanced forces, with zero acceleration.

If the water enters the space with velocity c_1, having a circumferential component c_{u1}, and leaves with velocity c_2 having a circumferential component c_{u2}, then, applying the well-known principle that the "impulse" or force exerted by W lb. of water of velocity V is WV/g, we shall have the moment exerted upon the ring of water by the entering streams, about the axis, equal to $Wc_{u1}r_1/g$, in which W is the total weight of water entering the ring per second. In the same manner the moment due to the backward reaction of the leaving stream is $Wc_{u2}r_2/g$, the amount of water leaving being the same as that entering in accordance with continuity of flow. The two moments must be equal and opposite, since otherwise the ring of water would indefinitely increase in velocity; so that neglecting the frictional resistance of the walls, we have for steady flow

$$\frac{Wc_{u1}r_1}{g} = \frac{Wc_{u2}r_2}{g}, \text{ or } r_1c_{u1} = r_2c_{u2}$$

This relation will apply in any unobstructed space of revolution, whether the flow is inward, axial, or outward. The principle is not new. It was known in the case of a vortex to Leonardo da Vinci.[1]

[1] Forchheimer, Hydraulik, p. 285.

The above relation means that in the free flow within such a space of revolution the velocity of whirl varies inversely as the radius. We can illustrate the use of this law by applying it to the familiar case of a free vortex in an open basin. If we neglect the components of velocity in the meridian plane and assume for an approximation that the velocity is entirely in the circumferential direction we shall have, referring to Fig. 5, $v = k/r$, r being the radius to any point in the surface and k a constant; and if z is the

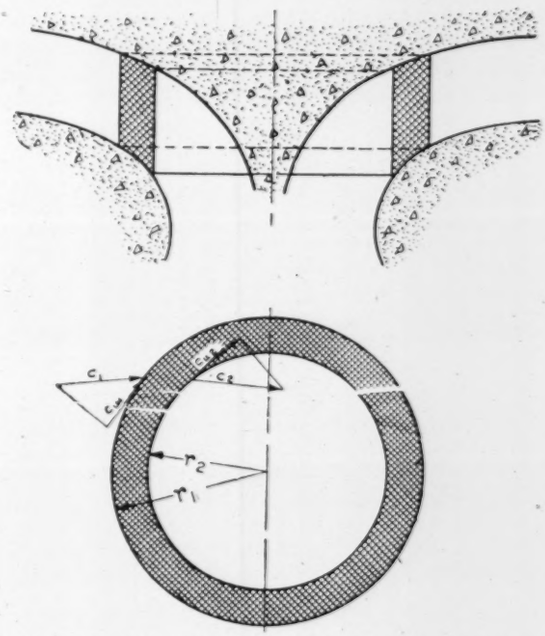


FIG. 4 FLOW IN TRANSITION SPACE IN ADVANCE OF RUNNER AND IN DRAFT TUBE

ordinate of the same point, then since the pressure at every point of the surface is atmospheric, and since therefore the velocity head must increase by the same amount that the elevation head decreases, we shall have $z = v^2/2g$. Combining the above expressions we have r^2z = (a constant). This is the equation of a third-degree hyperbola, which agrees closely with the surface of a free vortex.

It is interesting to note that where there is a whirl component of velocity in the flow in such spaces of revolution there must be a surface of discontinuity bounding the flowing stream, similar to the surface of the above vortex, since if the flow should approach the axis more closely the velocity of whirl would be required by the above relation to approach infinite values. When the space within the surface of discontinuity is filled with water it is likely that this water is set into an eddying condition without partaking of the general flow of the surrounding stream.

THE SPREADING TYPE OF DRAFT TUBE

The principle just explained suggests a useful method of regaining the kinetic energy of the whirling component of flow in the water discharged from a turbine runner or pump impeller. For example, if the flow is turned into an outward direction, away from the axis, the velocity of whirl will diminish in inverse proportion to the increasing radius, and the corresponding velocity head will diminish inversely as the square of the radius, so that it is merely necessary to lead the water a moderate distance away from the axis to obtain the conversion of a large proportion of the velocity head of whirl into pressure head. This principle is used in the spreading type of draft tube.

The construction of this tube can be understood from Fig. 6, which shows a model of the draft tubes of the 30,000-hp. turbines for the United States Government Plant at Muscle Shoals, Alabama.

In utilizing this principle in the design of a turbine draft tube the meridian components of flow must not be lost sight of, and sufficiently gradual reduction in the meridian components must be provided, without sudden changes in direction. Both for the

avoidance of rapid changes in velocity and direction of the meridian components, and also to avoid a surface of discontinuity and the presence of a region of eddies, the value of including in the draft-tube design a central cone or core is clear. When a turbine draft tube is short, and when a long and awkward structure is not required to do it, it may be advisable to carry the central core up to the runner discharge, thus avoiding all flow close to the axis where the tendency to form a vortex or vortices is great. The writer also suggests the use of continuously curved inner and outer

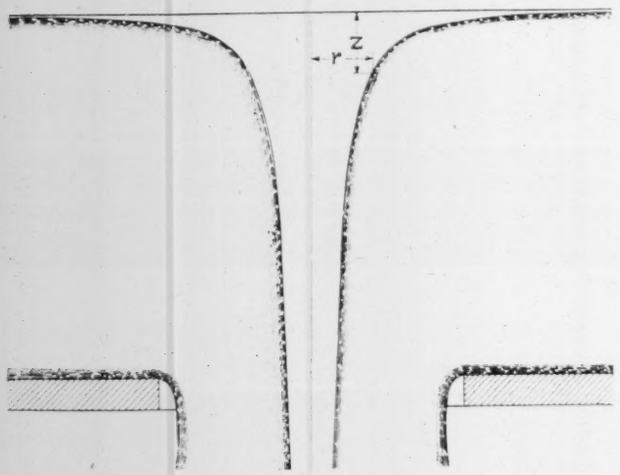


FIG. 5 VORTEX FLOW IN UNOBSTRUCTED SPACE OF REVOLUTION

surfaces of revolution for the turbine water passage, thus avoiding all sudden changes in curvature. Fig. 7 shows in outline a turbine which follows these principles.

A NEW FORM OF TURBINE

In this new turbine form the entrance passage merges into the

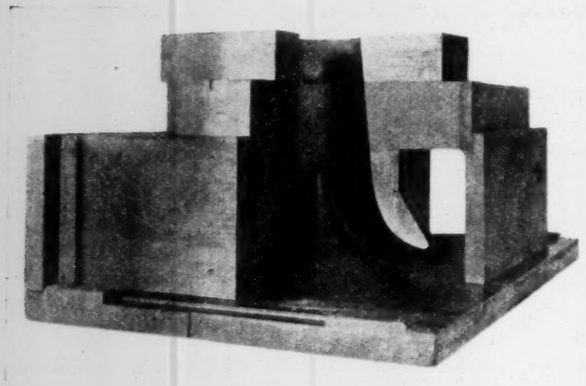


FIG. 6 MODEL OF SPREADING DRAFT TUBE OF 30,000-HP. TURBINES AT MUSCLE SHOALS PLANT

runner space and the latter merges into the draft tube, and the flow passes into the draft tube by a continuous gradation, with gradual changes in the whirl about the turbine axis and without sudden variations of the secondary whirl occurring in the meridian plane, i. e., the plane of the figure.

If a ring of vanes such as a runner is interposed in the revolving mass of water, the torque exerted on the vanes by the water is equal to

$$\frac{W}{g}(r_1 c_{u1} - r_2 c_{u2}).$$

New forms of runner suited to the new types of high-speed turbine here considered are shown in Fig. 8, which may be contrasted with the series of runners of the more usual type shown in Fig. 3.

DRAFT-TUBE AND RUNNER-VANE FRICTION LOSSES

Taking up some of the theoretical conditions presented by the modern forms of turbine, it will be recalled that in practically all of the time-honored turbine theories the design is based on the radial or axial direction of discharge from the runner; that is, for the conditions of best efficiency the absolute direction of outflow from the runner is assumed to be in a meridian plane, a plane containing the axis. That this is not actually the best direction of discharge for high-speed runners has been known for several years, as found from pitot-tube and direction-vane investigations in draft tubes.

With the use of the earlier forms of draft tube any direction of discharge having a whirl component introduced uncertainties and complications in the formulas, and the problem was not attractive. With the use of a draft tube capable of efficiently regaining the energy of whirl components as well as of meridian components of flow, however, it becomes possible to formulate some simple relations which it will be interesting to investigate. For one thing we shall no longer have to make the outflow loss from the runner dependent upon the direction of discharge, since we can use a draft tube which will handle the whirl components just as efficiently as the meridian components; the outflow loss from the runner can therefore be expressed as a function merely of the amount of the discharge velocity regardless of its direction. If the draft-tube efficiency is e_d and the coefficient of loss in the draft tube f_3, the portion of the velocity head of the water discharged from the runner which is lost or dissipated will be $f_3 c_2^2/2g$; c_2 being the absolute velocity of discharge from the runner and $f_3 = 1 - e_d$.

In runners of high specific speed another important loss is that due to the frictional resistance of the runner vanes, since very high relative velocities between the vanes and water are employed. In recent forms of high-speed turbines, such as just shown in Fig. 8, the rotational speed is high and the torque correspondingly low, so that the runner vanes have but little curvature and deflect the water only in small amounts. The loss of head due to the frictional resistance of the runner vanes can be expressed as $f_2 w_2^2/2g$, in which w_2 is the relative velocity with which the vanes move through the water, measured at their outflow edges. (For the reason just

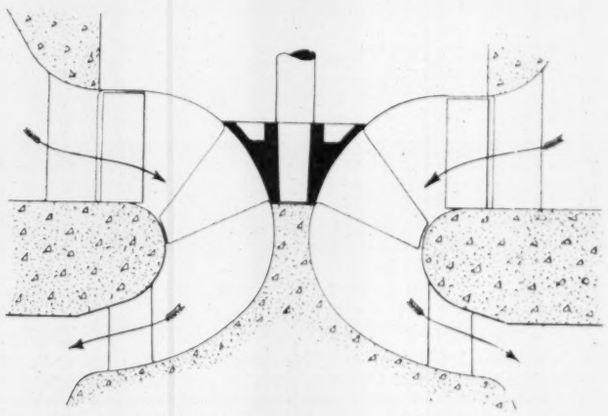


FIG. 7 A NEW FORM OF TURBINE

mentioned, however, the relative velocity is nearly the same over the whole vane.)

Instead of making any arbitrary assumption regarding the direction of discharge upon which to base our turbine design, it will be useful to find the conditions which will give the minimum value for the sum of the above two losses—the outflow loss from the runner and the resistance loss in the runner. The problem may be stated as the determination of the conditions for maximum efficiency for a given specific speed or of maximum specific speed for a given efficiency.

Before proceeding with the problem itself, a distinction between two expressions for specific speed now in use should be explained. The usual formulation for specific speed used in turbine work is $N_s = N\sqrt{\text{hp.}}/H^{5/4}$. This form of specific speed is useful in turbine work because we most frequently have to fix the turbine

speed when the horsepower output and the head have been decided upon. In centrifugal-pump problems, however, we commonly define specific speed as $N_s = N\sqrt{Q}/H^{3/4}$, since the discharge and head are usually the known quantities. The two expressions are derived from the same dimensional relations and the second is just as applicable to turbines as to pumps, and the first as applicable to pumps as to turbines. Let us distinguish by calling the specific speed based on quantity $N_{sQ} = N\sqrt{Q}/H^{3/4}$. Although in adapting turbines of types already developed to new requirements of head and power the first expression is more convenient, the second has advantages when the problem is the development of a new design or type, since by its use we may design for a desired discharge under a definite head without introducing unnecessary uncertainty by having to assume an efficiency in advance. Moreover, if the efficiency should turn out to be materially different from that expected, the discharge and velocities will not be thrown so far out of agreement with the designed values if taken for a given N_{sQ} as they would be if taken for a given N_s. In stepping a small turbine up to a larger size the N_{sQ} will remain more nearly constant than the N_s.

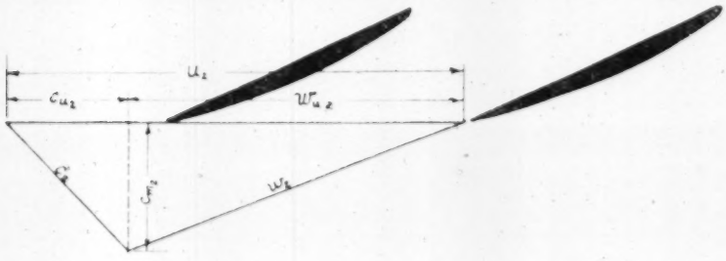
In the problem in hand we will gain simplicity by employing N_{sQ}, and if we determine the conditions for maximum N_{sQ} for a given efficiency we shall at the same time have found those for the maximum N, since

$$N = \sqrt{\frac{62.4}{550}} \times N_{sQ}\sqrt{\eta}$$

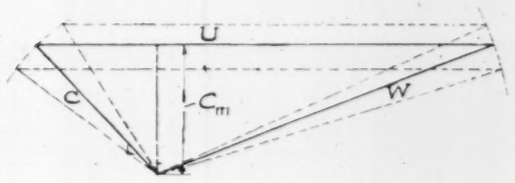
and the conditions which will give the best efficiency for a given N_{sQ} will also give the best efficiency for a given N_s.

The writer might mention, in passing, his belief that the knowledge of hydraulics has gained more from the study of dimensional relations such as the principles of similarity and specific speed than from any other method; and it may not be altogether fanciful to think of these relations as corresponding in a minor degree with the "relativity" movement in abstract philosophy.

To resume the problem of finding the conditions for the maximum value of the sum of the two losses mentioned, the "outflow triangle" of velocities is drawn as in Fig. 9(*a*) with the velocities marked to show the notation which is here used (the system which has now become standard in Europe).[1]



(*a*)



(*b*)

FIG. 9 OUTFLOW TRIANGLE OF VELOCITIES

Velocity of runner vanes = $u_2 = (\pi D_2/60)N$. Meridian velocity component of water = $C_{m2} = Q/A$. Specific speed based on quantity = $N_{sQ} = N\sqrt{Q}/H^{3/4} = (60\sqrt{A}/\pi D_2 H^{3/4})u_2\sqrt{C_{m2}}$

Here c_2 = absolute discharge velocity from runner
w_2 = relative discharge velocity from runner
u_2 = velocity of runner
c_{m2} = meridian component of velocity of discharge
c_{u2} = whirl component of absolute velocity of discharge, which may we call the "absolute whirl," and
w_{u2} = whirl component of relative velocity of discharge which we may call the "relative whirl."

Since we are not concerned with any particular value of the head, we can adopt a "specific" value for each velocity, using the device of Thomann,[2] which is convenient in problems of this kind, and call

$$C_2 = \frac{c_2}{\sqrt{2gH}}; \quad W_2 = \frac{w_2}{\sqrt{2gH}}; \quad U_2 = \frac{u_2}{\sqrt{2gH}}, \text{ etc.}$$

and as we shall deal throughout with the outflow triangle, we can omit the subscripts (2).

The form of the triangle can easily be related to the specific speed by putting $U_2 = \pi D_2 N/60\sqrt{2gH}$ and $C_{m2} = Q/A\sqrt{2gH}$, in which A is the area of the turbine passage at the runner discharge measured normally to C_{m2}.

Then

$$N_{sQ} = \frac{60\sqrt{2gH}}{\pi D_2} U_2 \frac{\sqrt{A}C_{m2}\sqrt{2gH}}{H^{3/4}} = \frac{60(2g)^{1/4}\sqrt{A}}{\pi D_2} U_2\sqrt{C_{m2}}$$

or, dropping subscript (2), $k_{sQ} N_{sQ} = U\sqrt{C_m}$, in which

$$k_{sQ} = \text{a constant} = \frac{\pi D_2}{60\,(2g)^{1/4}\sqrt{A}}$$

Before considering the problem with reference to the amounts of the vane loss and outflow loss, we can reach an interesting conclusion simply by supposing that the magnitude of the absolute and relative velocities C and W are kept constant while their directions are changed until the most advantageous shape of outflow triangle is attained. As shown in Fig. 9(*b*) various shapes of outflow triangle can be drawn with the same values of C and W, and therefore with the same losses of head. There will be one of these triangles which will give the highest specific speed, which we have just seen is proportional to $U\sqrt{C_m}$. To find the relation which will thus give the maximum N_{sQ} for a given loss, we can put

$$k_{sQ} N_{sQ} = U\sqrt{C_m} = (\sqrt{C^2 - C_m^2} + \sqrt{W^2 - C_m^2})\sqrt{C_m}$$

and considering C and W to be constant, we can differentiate $(k_{sQ} N_{sQ})$ with respect to C_m and equate to zero:

$$\frac{k_{sQ}\, dN_{sQ}}{dC_m} = (\sqrt{C^2 - C_m^2} + \sqrt{W^2 - C_m^2})\frac{1}{2\sqrt{C_m}} - \sqrt{C_m}\left(\frac{C_m}{\sqrt{C^2 - C_m^2}} + \frac{C_m}{\sqrt{W^2 - C_m^2}}\right) = 0$$

From this we have, simplifying,

$$\sqrt{C^2 - C_m^2} + \sqrt{W^2 - C_m^2} = 2C_m^2\left(\frac{1}{C^2 - C_m^2} + \frac{1}{W^2 - C_m^2}\right)$$

and substituting C_u for $\sqrt{C^2 - C_m^2}$ and W_u for $\sqrt{W^2 - C_m^2}$,

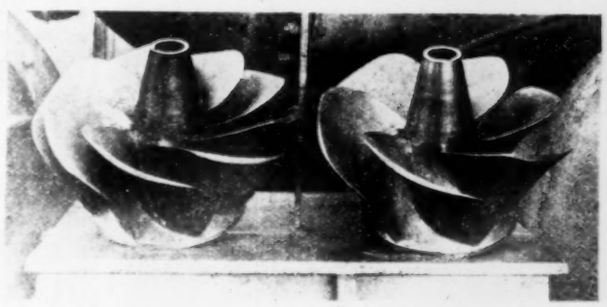


FIG. 8 NEW FORMS OF RUNNER SUITED TO NEW TYPES OF HIGH-SPEED TURBINE

[1] See Camerer, Wasserkraftmaschinen, 1914, pp. iv, vii and viii.
[2] R. Thomann, Die Wasserturbinen, 1908, pp. 11–12.

$$C_u + W_u = 2C^2_m\left(\frac{1}{C_u} + \frac{1}{W_u}\right); \text{ or } U = 2C^2_m\left(\frac{W_u + C_u}{C_u W_u}\right) = \frac{2C^2_m U}{C_u W_u}$$

which gives $C_m = \sqrt{C_u W_u/2}$ as the most advantageous proportion. That is, the meridian velocity should be chosen as 0.707 multiplied by the mean proportional of the absolute whirl and relative whirl. In calculations applying to the runner as a whole, the velocities corresponding to an average point in the runner may be used, such as the center of area of a sector of the discharge space.

Fig. 10 enables us to visualize the meaning of this relation.

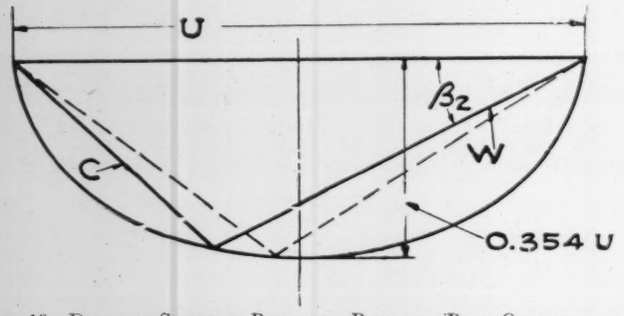


FIG. 10 DIAGRAM SHOWING PROBABLE POINT OF BEST OPERATION FOR RUNNER WITH VANE INCLINATION β_2

The vertex of the outflow triangle should fall somewhere on the ellipse of major axis U and semi-minor axis =

$$0.707\sqrt{\frac{U}{2} \times \frac{U}{2}} = 0.354\ U$$

For example, if a runner has a vane inclination β_2 its probable

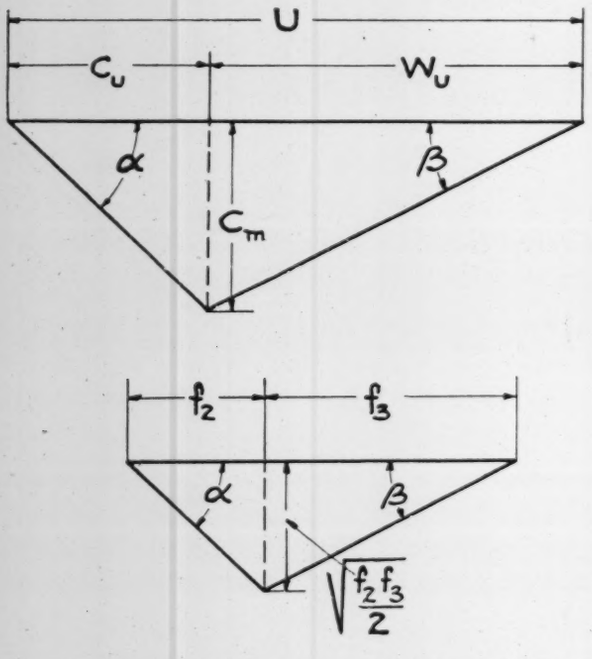


FIG. 11 RELATIONS OF VARIOUS OUTFLOW VELOCITIES FROM THE RUNNER TO EACH OTHER

point of best operation can be found by drawing W at this angle with the base line and completing the triangle with the vertex at the point where the W line intersects the ellipse. According to this diagram, it would evidently never pay, from the standpoint of efficiency alone, to use a meridian velocity greater than 35.4 per cent of the circumferential velocity of the runner. Since the meridian velocity may be somewhat increased, however, before the efficiency is seriously impaired, it will probably be economical to use slightly higher values of C_m than are called for by this relation, in order to reduce the turbine dimensions and cost.

Now proceeding with the problem, and considering the amounts of the losses of head, we can derive some useful relations, as follows:

From the above expression for specific speed, we see that we can keep the length of base U of the outflow triangle and its altitude C_m constant, and can change its shape without changing the specific speed. By shifting the vertex parallel to the base, there must be some position which will make the sum of the outflow loss and vane resistance loss a minimum.

Calling the sum of these losses H_L, the loss of head expressed as a fraction of the effective head is

$$h_L = \frac{H_L}{H} = f_2\frac{w_2^2}{2gH} + f_3\frac{c_2^2}{2gH} = f_2W^2 + f_3C^2$$

Expressing h_L in terms of U, C_m and C_u,

$$\begin{aligned} h_L &= f_2W^2_u + f_3C^2_u + (f_2 + f_3)C^2_m \\ &= f_2U^2 + f_2C^2_u - 2f_2UC_u + f_3C^2_u + (f_2 + f_3)C^2_m \\ &= f_2U^2 + (f_2 + f_3)C^2_u - 2f_2UC_u + (f_2 + f_3)C^2_m \end{aligned}$$

For a given U and C_m we can find the value of C_u which will make h_L a minimum, neglecting the effect of any small variation of f_2 due to a change in direction of W as being of a higher order of small quantities than differences in the losses themselves. Then

$$\frac{dh_L}{dC_u} = 2(f_2 + f_3)C_u - 2f_2U = 0$$

That is,

$$C_u = \frac{f_2}{f_2 + f_3}U, \text{ or } f_2(U - C_u) = f_3C_u$$

from which

$$f_2W_u = f_3C_u, \text{ or } \frac{C_u}{W_u} = \frac{f_2}{f_3}$$

This means that for the best efficiency the absolute whirl should

FIG. 12 NEW TYPE OF HIGH-SPEED PUMP IMPELLER

be to the relative whirl as the coefficient of frictional loss is to the coefficient of outflow loss.

The above result shows for one thing that in a runner for which f_2 is large, as is the case in runners having a large amount of vane surface—particularly when this surface is increased by an outer band—the best condition of operation will be with comparatively low relative whirl and high absolute whirl, so that such runners will discharge the water at a greater angle of inclination to the meridian plane than runners having less vane surface and correspondingly lower f_2. The numerical value of f_2 can be calculated by figuring the loss of head in the runner buckets considered as rectangular channels. The purpose of this investigation is not so much to take up questions of design and calculation, however, as to establish some of the controlling relations, and we will give less attention to the numerical values of the coefficients than to the general conclusions which may result.

Having established the above relation between the relative whirl and absolute whirl at the runner discharge, we can now proceed, assuming that the said relation is to be complied with,

to find the best relation between the meridian velocity C_m and the velocity of the runner U. Expressing the loss of head in terms of U and C_m in the expression,

$$h_L = f_2U^2 + (f_2 + f_3)C_u^2 - 2f_2UC_u + (f_2 + f_3)C_m^2$$

by expressing C_u in terms of U according to the result just obtained above, namely, $C_u = [f_2/(f_2 + f_3)]U$, we have

$$h_L = \frac{f_2f_3}{f_2 + f_3}U^2 + (f_2 + f_3)C_m^2$$

Substituting in this

$$U = k_{sQ}N_{sQ}\sqrt{C_m}$$

we have

$$h_L = \frac{f_2f_3}{f_2 + f_3} \times \frac{k^2_{sQ}N^2_{sQ}}{C_m} + (f_2 + f_3)C_m^2$$

To obtain the conditions for minimum h_L for a given N_{sQ} we will differentiate the last expression with respect to C_m, considering N_{sQ} a constant, and will equate the derivative to zero:

$$\frac{dh_L}{dC_m} = -\frac{f_2f_3}{f_2 + f_3} \times \frac{k^2_{sQ}N^2_{sQ}}{C^2_m} + 2(f_2 + f_3)C_m = 0$$

from which, replacing $k_{sQ}N_{sQ}/\sqrt{C_m}$ by U, we have

$$2(f_2 + f_3)C_m = \frac{f_2f_3}{f_2 + f_3} \times \frac{k^2_{sQ}N^2_{sQ}}{C^2_m} = \frac{f_2f_3}{f_2 + f_3}\frac{U^2}{C_m}$$

From this we obtain

$$\frac{C_m}{U} = \frac{\sqrt{1/2}(f_2f_3)}{(f_2 + f_3)}$$

The same result is called for by the relation $C_m = \sqrt{C_uW_u}\ 2$, already given, if we insert

$$C_u = \frac{f_2}{f_2 + f_3}U \text{ and } W_u = \frac{f_3}{f_2 + f_3}U$$

From the minimum loss for a given specific speed the various outflow velocities from the runner should therefore be related to each other in the proportions shown at the top in Fig. 11, which is geometrically similar to the outflow diagram as indicated in the lower part of the same figure. That is, C_u, W_u, C_m and U should be to each other respectively as f_2, f_3, $\sqrt{\frac{f_2f_3}{2}}$ and $(f_2 + f_3)$.

From the last-mentioned figure it is seen that

$$\tan\beta_2 = \sqrt{\frac{1}{2}\frac{f_2}{f_3}} \text{ and } \tan\alpha_2 = \sqrt{\frac{1}{2}\frac{f_3}{f_2}}$$

In order to use advantageously small values of β_2, to secure runners of very high specific speed, it therefore becomes necessary to obtain low values of f_2, and thereby to avoid the necessity for high angles of whirl at the runner discharge. These small values of f_2 can be secured by reducing the exposed runner surface to a minimum. If this reduction of vane area is carried too far, however, another source of loss will be introduced due to permitting the passage of a considerable portion of the flow between the vanes without its acting effectively upon them.

The foregoing relations are as applicable to pumps as to turbines, and furnish a helpful guide in proportioning the absolute whirl, the relative whirl and the meridian velocity component in designing both turbines and pumps of high specific speed. Fig. 12 shows a new type of high-speed pump impeller.

In looking forward to the future development of the turbine, it can be seen from the foregoing that theoretic considerations

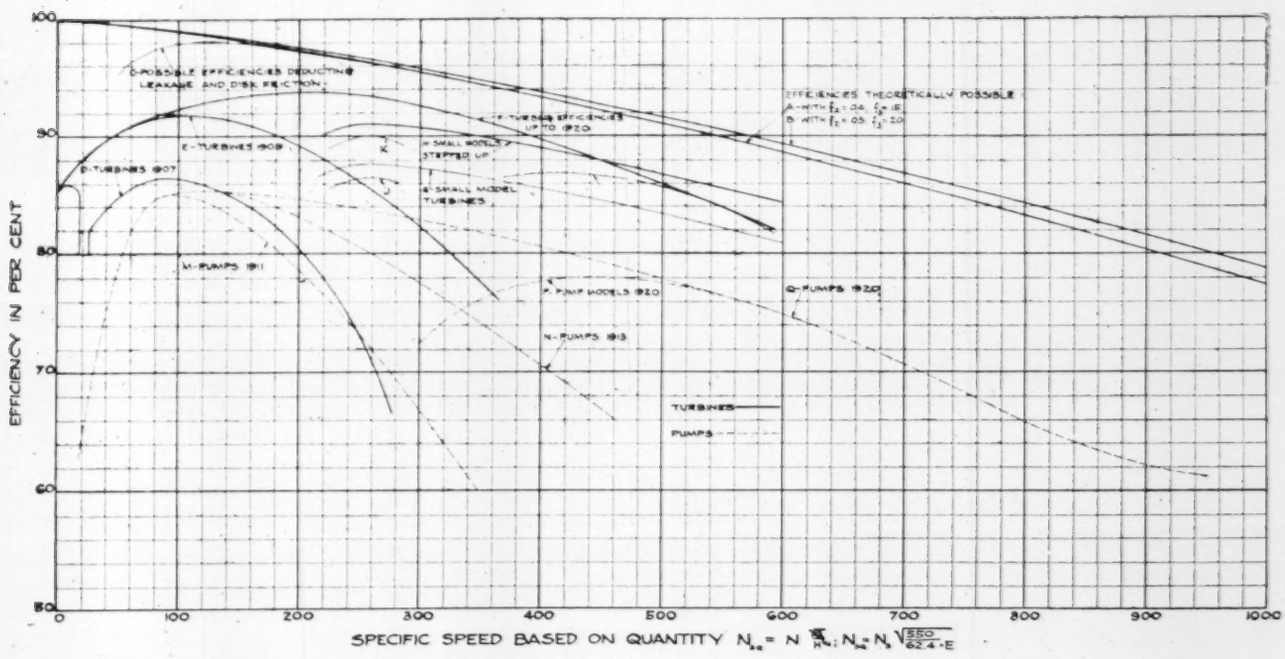


FIG. 13 CURVES OF TURBINE AND PUMP EFFICIENCIES PLOTTED AGAINST SPECIFIC SPEED BASED UPON QUANTITY N_{sQ}

A—Calculated efficiencies based on loss in runner = $f_2w_2^2/2g$ and discharge loss from runner = $f_3c_2^2/2g$ with $f_2 = 0.04$, $f_3 = 0.15$, and neglecting other losses

B—Calculated efficiencies with $f_2 = 0.03$ and $f_3 = 0.20$

C—Calculated efficiencies deducting leakage loss ($= 50/N^2_{sQ}$) and disk-friction loss ($= 6/N^2_s$)

D—Turbine efficiencies attained in Europe up to 1907 (from paper by Graf and Thoma, *Zeit. Ver. Deutsch. Ing.*, June 29, 1907)

E—Turbine efficiencies attained in America and Europe up to 1909 [from discussion by L. F. Moody of paper by C. W. Larner in Trans. Am.Soc.C.E., vol. lxvi, p. 306 (1910)]

F—Turbine efficiencies attained up to 1920 from tests so far reported

G—Efficiencies of small model turbines (16-in. diam.) in I. P. Morris Hydraulic Laboratory of Cramp Shipbuilding Co.

H—Efficiencies of Curve G stepped up to Holyoke size, based on comparison of Holyoke test (Curve K) and geometrically similar model (Curve J) of 16-in. diam. at I. P. Morris Laboratory

J—Test of small model of Cedars Rapids type turbine at I. P. Morris laboratory

K—Holyoke test of larger model of Cedars Rapids type turbine

L—Efficiencies from paper by Forrest Nagler, Trans. Am.Soc.M.E., vol. 41, p. 829 (1919)

M—Efficiencies of centrifugal pumps from Greene's Pumping Machinery, 1911

N—Efficiencies of centrifugal pumps up to 1913

P—Tests of 12-in. pump models of author's spiral type at I. P. Morris Laboratory up to 1920

Q—Pump efficiencies attained up to 1920

call for a conservative proportioning of the various velocities and angles of the turbine, and that there is no apparent means of greatly increasing specific speeds merely by using some new and radical proportion between the velocities. Efficiencies are already so high that no startling increase is possible. The prospect of further increases in specific speed therefore lies entirely in the use of higher velocity heads in comparison with the head on the plant, and an avoidance of serious impairment of the efficiency, by giving attention to the securing of low coefficients of loss in the runner and draft tube, and by observing the relations between the velocities deduced above.

Possibilities of Further Increase in Specific Speed

To get some idea of the possibilities of further increases of specific speed, it may be pointed out that if the best relation between the velocities is adhered to the losses here considered will vary as the four-thirds power of the specific speed N_{sQ}, the functional relation between efficiency and N_{sQ} being derived in the following manner:

$h_f = \frac{f_2 f_3}{f_2 + f_3} U^2 + (f_2 + f_3) C_m^2$; and from $\frac{C_m}{U} = \sqrt{\frac{f_2 f_3}{2}}$,

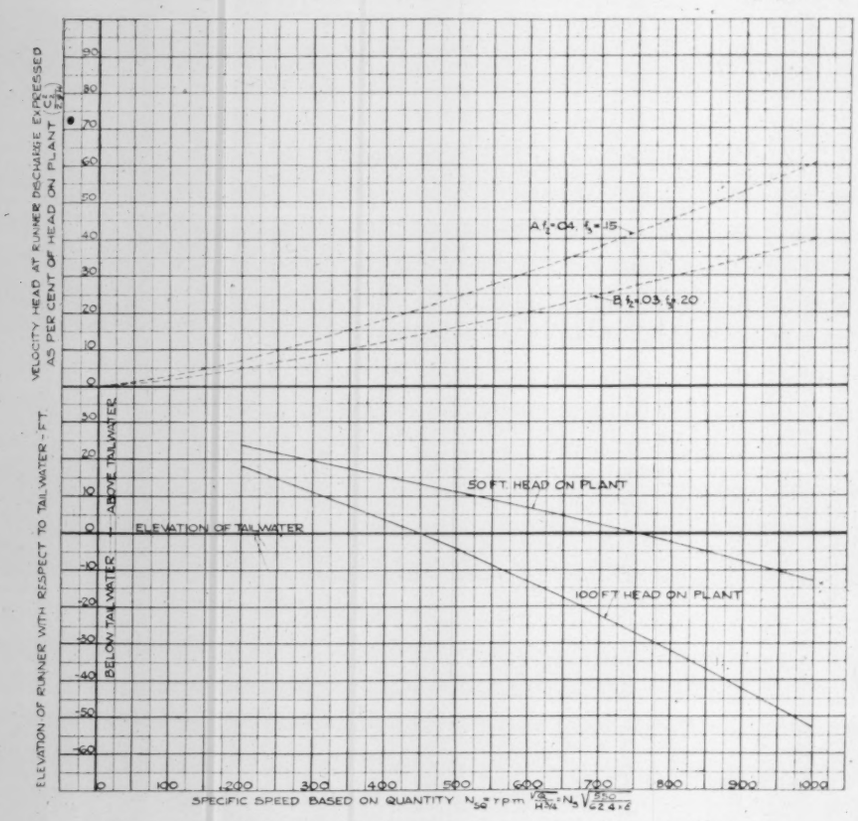

VELOCITY HEAD AT RUNNER DISCHARGE EXPRESSED AS PER CENT OF HEAD ON PLANT $\left(\frac{C_2^2}{2gH}\right)$
ELEVATION OF RUNNER WITH RESPECT TO TAILWATER - FT
ABOVE TAILWATER
BELOW TAILWATER
ELEVATION OF TAILWATER
A f_2=.04 f_3=.15
B f_2=.03 f_3=.20
50 FT. HEAD ON PLANT
100 FT. HEAD ON PLANT
SPECIFIC SPEED BASED ON QUANTITY $N_{sQ} = \frac{N\sqrt{Q}}{H^{3/4}} = N_s\sqrt{\frac{550}{62.4\times 2}}$

Fig. 14 Curve Showing Restriction Placed upon Specific Speed by Location of Turbine with Respect to Tailwater

$h_L = 3(f_2 + f_3)C_m^2$; and also, from $k_{sQ}N_{sQ} = U\sqrt{C_m} = \sqrt{\frac{f_2 f_3}{2}}^{1/2} C_m^{3/2}$

$h_L = \frac{3}{2^{3/2}} \times \frac{(f_2 f_3)^{3/2}}{(f_2 + f_3)^{1/2}} k_{sQ}^{4/3} N_{sQ}^{4/3}$, and

$$\text{efficiency} = 1 - \frac{3}{2^{3/2}} \times \frac{(f_2 f_3)^{3/2}}{(f_2 + f_3)^{1/2}} k_{sQ}^{4/3} N_{sQ}^{4/3}.$$

This considers the effect of only the two losses here treated of, and neglects certain other losses. These values of efficiency are therefore merely indications of the limiting values attainable.

The two losses mentioned account for nearly the whole loss in turbines of high specific speed. In low-speed machines two other losses assume importance—those due to leakage and disk friction. These losses can be shown to be given approximately by the following formulas:[1]

[1] For derivation see paper on The Specific Speed of Hydraulic Turbines by the writer, presented at December 28–30, 1908, meeting of Am. Assn. for Advancement of Science, and printed in *The Polytechnic* of Rensselaer Poly. Inst., 1913.

Leakage loss, expressed as a fraction of the total quantity, is equal to

$$L_L = \frac{q_L}{Q} = \frac{201\,\phi^2}{N_{sQ}^2},$$

where ϕ has the usual significance; i. e.,

$$\phi = \frac{\pi D N}{60\sqrt{2gH}}$$

and disk-friction loss, expressed as a fraction of the total power, is equal to

$$L_D = \frac{l_f}{\text{hp.}} = \frac{35\,\phi^5}{N_s^2},$$

and for present purposes a still rougher approximation will be sufficient, giving

$$L_L = \frac{100}{N_{sQ}^2} \text{ and } L_D = \frac{6}{N_s^2}.$$

When labyrinth seals are used for the runner, the above leakage loss, which is for ordinary seals, may be as roughly equal to $L_L = 50/N_{sQ}^2$ or even less. We shall find that these losses become negligible at moderate values of N_s and N_{sQ} and are of no importance in the high-speed field which we are particularly investigating.

Turbine and Pump Efficiencies as Related to Specific Speed

In Fig. 13 are shown a series of curves of efficiency plotted against N_{sQ}. Curve A is the attainable efficiency computed from the theoretic relation derived above, using as values of the coefficients $f_2 = 0.04$ and $f_3 = 0.15$. To show the effect of altering the coefficients, Curve B has been plotted with $f_2 = 0.03$; $f_3 = 0.20$. The effect of leakage and disk friction has been shown by deducting these losses from the efficiencies given by Curve A, and Curve C shows the result (the leakage loss being figured for turbines having labyrinth seals).

To show the general progress which has been made in recent years, and the continuing trend toward higher specific speeds, a number of other curves have been plotted in the same figure, four of them being for pumps.

It is interesting to note the similarity in the form of Curves G and H with A and B. As more development work is carried out in the high-specific-speed field, it may be expected that the efficiencies shown by Curves F and Q, for both turbines and pumps, will be materially exceeded and brought in closer relation to the theoretic values of Curves A and B, assuming that the coefficients used in computing these curves can be more closely approached.

The generally lower range of values of pumps as compared to turbines at all specific speeds is not entirely due to essential differences in action, but much of the difference the writer believes to be attributable to the generally smaller dimensions of pumps; although the pump suffers a definite disadvantage in its action from the fact that in the pump the impeller imparts velocity head to the fluid and depends upon a stationary diffuser for the reconversion of this velocity head into pressure head; while in the turbine pressure head is converted into velocity head in the stationary casing and guides, and is absorbed in the runner, leaving only a small portion for reconversion in the draft tube.

Going back to the theoretic conditions for best efficiency or higher specific speed, let us see what is involved in the increases in specific speed shown by Curves A and B. These high specific speeds are imagined to be attained without changing the proportioning of the velocities relatively to each other, but by increasing the magnitudes of all of them, and thus requiring the use of higher velocity heads in comparison with the head on the plant. To see what this means in actual values, we can determine the manner in which the absolute velocity of discharge from the runner

varies with respect to N_{sQ}. The derivation is as follows:

Referring to the proportions shown in the triangles of Fig. 11,

$$\frac{C_m}{C} = \frac{\sqrt{\frac{f_2 f_3}{2}}}{\sqrt{f_2^2 + \frac{f_2 f_3}{2}}} \qquad \frac{U}{C} = \frac{f_2 + f_3}{\sqrt{f_2^2 + \frac{f_2 f_3}{2}}}$$

We also have

$$k_{sQ} N_{sQ} = U \sqrt{C_m} = \frac{(f_2 + f_3)\left(\frac{f_2 f_3}{2}\right)^{1/4}}{\left(f_2^2 + \frac{f_2 f_3}{2}\right)^{3/4}} C$$

and hence

$$C^2 = \frac{\left(f_2^2 + \frac{f_2 f_3}{2}\right)^{3/2}}{(f_2 + f_3)^2 \left(\frac{f_2 f_3}{2}\right)^{1/2}} k_{sQ}^2 N_{sQ}^2$$

or

$$C^2 = \frac{C_2^2}{2gH} = \frac{\left(1 + \frac{f_3}{2f_2}\right)^{3/2}}{\left(1 + \frac{f_3}{f_2}\right)^2 \left(\frac{f_3}{2f_2}\right)^{1/2}} k_{sQ}^2 N_{sQ}^2$$

From the last equation values of C^2, which represents the ratio of the velocity head of the water at discharge from the runner to the head on the turbine, can be computed for various values of the specific speed. As previously noted, the term k_{sQ} in the formula for C^2 is a coefficient having the value

$$k_{sQ} = \frac{\pi D_2}{60\,(2g)^{3/4} \sqrt{A}}$$

In this expression D_2 should be taken as the mean diameter of discharge of the runner and A the cross-sectional area of the space into which the runner discharges, measured in a section perpendicular to the turbine axis. In a runner in which the direction of the meridian velocity of discharge is at a moderate inclination to the axis and having vanes extending nearly to the axis, D_2 may be taken as approximately equal to $^2/_3\ D$, where D is the diameter of the outflow space. This gives us

$$k_{sQ} = \frac{\sqrt{\pi}}{45\,(2g)^{3/4}} = 0.00174$$

The computation has been carried out for the two sets of values of f_2 and f_3 which were used in plotting Curves A and B in Fig. 13. Fig. 14 (upper diagram) shows the corresponding values of C^2, the curves in this figure being marked A and B to correspond to Fig. 13.

The ordinates of these curves represent the velocity head corresponding to the absolute velocity of discharge from the runner, expressed as a percentage of the head on the turbine. With the low values of the coefficients f_2 and f_3 which have been used in computing these curves, the possibility is shown of developing

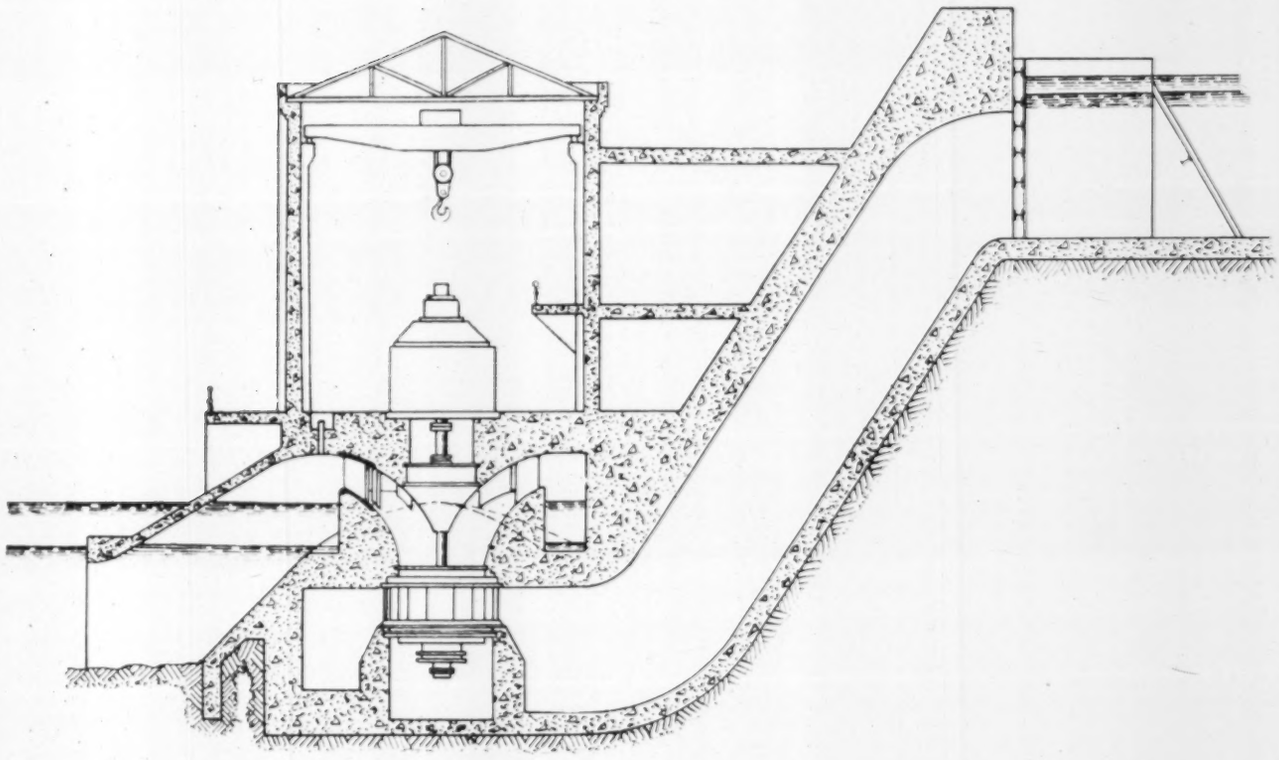


FIG. 15 NEW TYPE OF POWER PLANT

much higher specific speeds than have yet been attained, and it is also seen that this can be done without the necessity of employing extremely high velocity heads. It may be found from later experience that somewhat higher velocity heads may be employed without serious loss in efficiency, in order to reduce the turbine dimensions. The exact numerical values of coefficients f_2 and f_3 which can be secured in the future remain for further investigation to show.

Whatever the values of the coefficients secured by a particular turbine design the relation indicated by the general form of the curves of the last figure will always apply, i. e., increases in specific speed to extremely high values will inevitably involve, sooner or later, the use of higher velocity heads at the runner discharge. In turbines arranged according to present practice the extent to which the increase in specific speed can be carried will be limited by the height of the turbine runner above the surface of the tailwater.

In order that the absolute pressure at the runner discharge should be kept at a sufficient margin above the point at which the water will vaporize, and to provide the necessary head for the retardation of flow during quick gate closures, the sum of the static elevation of the runner above the tailwater surface and the regained velocity head should not approach unduly close to the barometric limit of 34 ft., and in the following examples the limit will be set at 27 ft. With such a limiting value, if a runner should be placed, say, 17 ft. above tailwater, there would remain only 10 ft. as the limit of the velocity head which can be employed, making the necessary allowance, however, for draft-tube losses,

distribution of velocity, and increase in velocity during full-gate operation.

In order to show in a general way the restriction placed upon specific speed by the location of the turbine with respect to tailwater, the curves shown in the lower part of Fig. 14 have been drawn, using Curve *A* in the upper portion of this figure as a basis, but adding 30 per cent to the velocity heads called for by this curve in order to provide a margin to cover certain factors, including the unequal distribution of velocities at the runner discharge and the variation in the absolute velocity from the normal point of operation up to full gate, the necessary margin being reduced, however, by the fact that velocity head is not completely regained by the draft tube. Two curves are shown in the figure, for plants operating respectively under heads of 50 ft. and 100 ft.

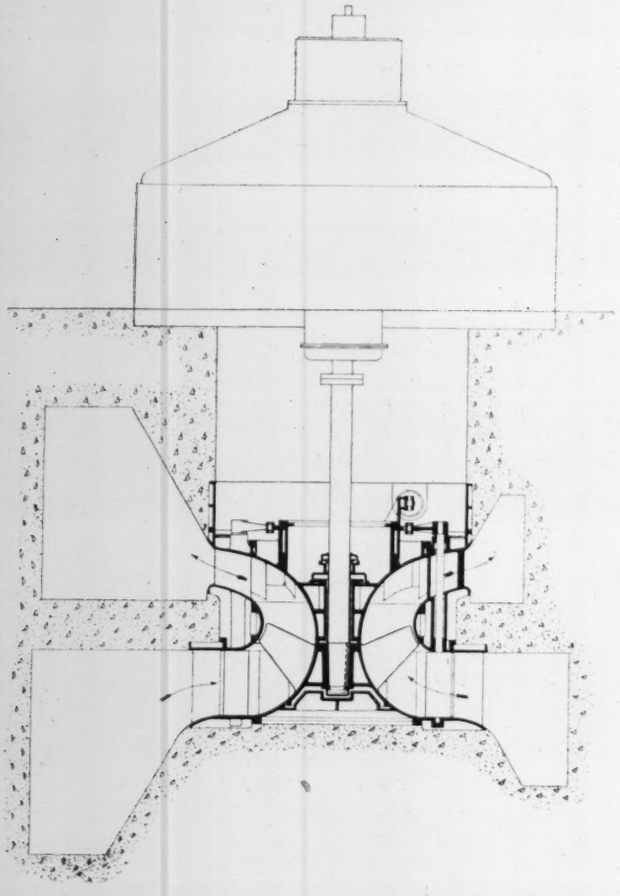


FIG. 16 INVERTED TURBINE OF THE WICKET-GATE TYPE

It will be noted that even with the low outflow losses called for by the types of turbine considered, a point is soon reached where the turbine must be set at the tailwater elevation or below it. If the turbine should be applied to heads higher than 100 ft., this point would occur at still lower specific speeds.

POWER PLANTS WITH INVERTED TURBINES AND DRAFT TUBES DIRECTED UPWARD FROM RUNNERS

If we should adhere to the usual practice in the design of power plants, the future extension of the available range of specific speeds for turbines would be narrowly restricted. The following procedure has, however, been proposed by Mr. H. Birchard Taylor, namely, that we remove this restriction on future progress and abandon the universal practice of placing the turbine runner at a considerable height above tailwater. Mr. Taylor proposes, if necessary, to locate the runner considerably below the normal tailwater elevation. The objection immediately presents itself that even if the runner is placed above normal tailwater it will be submerged and inaccessible during times of high water. This difficulty is overcome by the very simple but somewhat radical procedure of turning the turbine upside down and directing the draft tube upward from the runner, so that it will discharge over a crest located slightly above the highest tailwater elevation to be encountered in a particular installation. Fig. 15 shows a power plant built in accordance with this idea, and Figs. 16 and 17 two new forms of inverted-type turbine which could be used in such a plant.

In Fig. 15 the turbine is arranged with wicket gates or movable guide vanes, operating from below in a pit provided for the purpose. The draft tube is of the spreading type, the outer barrel of the tube being used to form a circular crest to exclude the tailwater when access is desired to the interior of the turbine. The procedure to follow would be to close the head gates and to pump out the water contained by the draft tube and turbine passages by the use of low-head centrifugal pumps or hydraulic ejectors.

Without going into all of the new features opened by this arrangement, it may be mentioned that the turbine casing, which is under a considerable amount of pressure, is located at a low point in the power-house substructure where there is a large mass of concrete above it to counteract the upward pressure of the water. An excellent design of draft tube can be used without requiring any increased depth of excavation, and the runner is naturally located at a low point in the substructure.

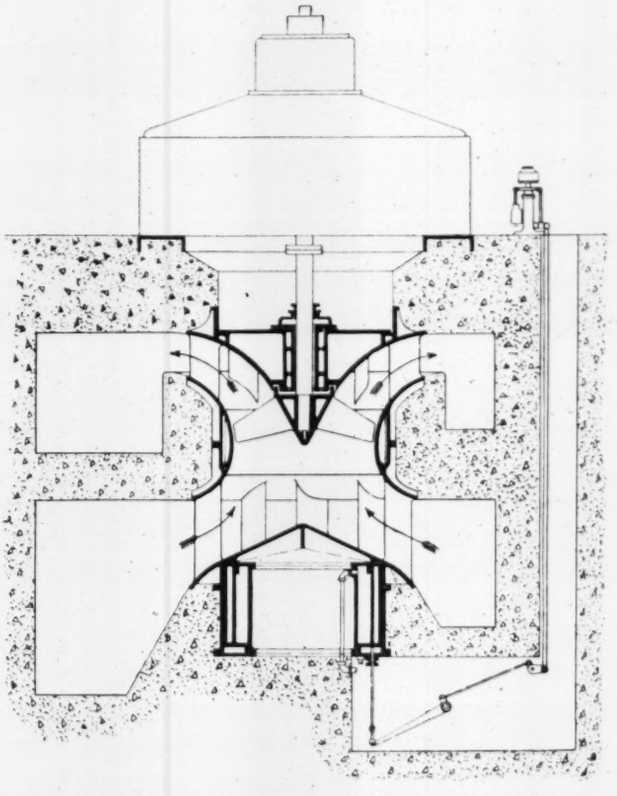


FIG. 17 INVERTED TURBINE OF THE PLUNGER-GATE TYPE

The arrangements shown in Figs. 16 and 17 can be readily understood from the drawings. In the turbine in Fig. 16 wicket gates are used with the guide-vane stems carried up through, or in line with, the draft-tube stay vanes which are used to support the superimposed structure, and "outside" operating mechanism is used, arranged in the usual manner in the turbine pit. In Fig. 17 a plunger gate is used instead of the usual wicket gates, this plunger being operated by hydraulic pressure.

In conclusion, the writer hopes that in pointing out some of the possibilities for the future development of the turbine, and some of the factors affecting its evolution, the suggestions presented in the foregoing pages may prove helpful to other engineers working in this field.

Speed Regulation of the Hydraulic Turbine

By RAYMOND D. JOHNSON,[1] NEW YORK, N. Y.

THERE is a more or less prevalent idea that the water-wheel governor, of itself, directly controls the speed of the units. The only direct function of a governor, however, is to alter the wheel-gate opening when impelled to do so by a slight change in the speed. It is also endued with more or less independent or secondary functions which check its natural motion and which introduce delay after the first impulse has become effectual.

These secondary adjustments may succeed in producing good speed regulation or they may not, regardless of the perfection of the governor itself and dependent entirely upon the thought which has been put into the general layout of the plant.

For example, consider a case of a long pipe line where the velocities are allowed to run too high in proportion to the head on the plant; any additional draft or water will of course lower the pressure at the power house, due to friction, and will therefore produce less power so far as the head is concerned, while at the same time it is producing more power from the additional amount of water. It may seem a fanciful thing that a condition could ever arise where the proportionate drop in head ould offset, in power, the extra a nount of water supplied, but it is so far from being fanciful that it has actually occurred in plants, in the region of gate openings between three-quarters and full. In fact, it occurs more often than is commonly supposed and it is a condition which is not always discovered by the operators. It is clear that the governor would have absolutely no control of the speed of the turbine under this extreme condition. A slight increment of load would drop the speed and impel the governor to open the gates wider without recovering any of the loss of speed but, nevertheless, causing a great waste of water to no purpose.

It may appear that such a condition is the result of such gross incompetence in design as to make it of little interest to real engineers, but this is not the case, because coöperation of the water-wheel characteristics and surges in pressure, due to increments of load, with insufficient area of the feeder pipe, may easily produce such results, even when the general features of the plant are arranged in more or less standard fashion. or example, suppose that the pipe line is more or less adequate, not nearly approaching the extreme condition as above mentioned, so that when additional water is called for there is a very decided increase in the power, in spite of the drop in hydraulic gradient; but, at the same time let us assume that the water wheel has been opened beyond its point of best efficiency, toward full gate, and that in so doing it has suffered a material loss in efficiency due to its drooping characteristic. In such a case the further opening of the wheel gates may cause to be delivered to the generator no more power than it received prior to the action of the governor. his may strike some as a hair-splitting contention, but it will be found, upon a brief investigation with actual figures, that the natter is a very important one.

Now let us suppose that both of these terms have been adequately considered and properly taken care of and that, nevertheless, the same trouble arises. This may be due to a drop in pressure caused by surging. In other words, even though the drop in pressure, due to the change of hydraulic gradient, is not sufficient to produce a permanent condition of impossible governing, yet the short duration drop in pressure, due to inertia of the water column as modified by a surge tank, may add to the trouble sufficiently to bring about the same difficulty.

It is also well to reme nber that these conditions do not have to exist in an extreme degree to render the speed regulation very unsatisfactory, but an approach to them may almost discount the efforts of the governor.

[1] Consulting Engineer, Mem.Am.Soc. M.E.

Abstract of a paper presented at the Symposium on Hydroelectric Development and Distribution, held at Philadelphia, January 21, 1921, under the auspices of the Engineers' Club of Philadelphia and the Philadelphia Sections of the American Society of Civil Engineers, the American Institute of Electrical Engineers and The American Society of Mechanical Engineers.

It is well known that the ordinary characteristic of the Francis turbine is such as to give a maximum efficiency at part gate and the manufacturers all show drooping curves beyond this point, up to full gate. The water wheel is ordinarily rated at its full-gate power.

Now, unless one has carefully studied the relation of the additional power to the additional water on the drooping part of this curve, it is fairly safe to say that he has little realization of exactly what this means.

A good way to study it is to plot a first differential curve showing the relation of added water to added power and to express the efficiency as such. In this way it will often appear that whereas the full-gate efficiency may be given as perhaps 88 per cent, the actual efficiency of small increments of water, compared to the

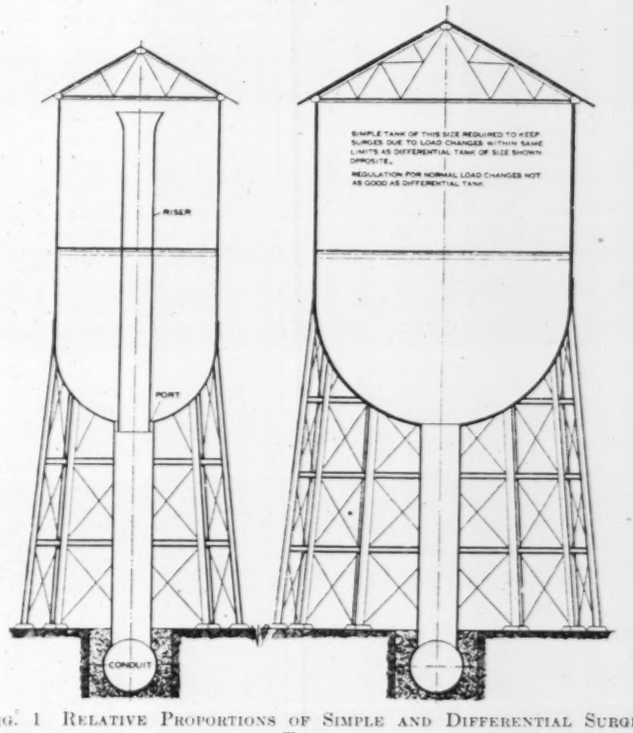

SIMPLE TANK OF THIS SIZE REQUIRED TO KEEP SURGES DUE TO LOAD CHANGES WITHIN SAME LIMITS AS DIFFERENTIAL TANK OF SIZE SHOWN OPPOSITE.
REGULATION FOR NORMAL LOAD CHANGES NOT AS GOOD AS DIFFERENTIAL TANK
RISER
PORT
CONDUIT

FIG. 1 RELATIVE PROPORTIONS OF SIMPLE AND DIFFERENTIAL SURGE TANKS

corresponding increments of power, may go as low as 25 or 30 per cent near full gate.

his stealing of additional water might not be of any great importance in an open-flume setting, but at the end of a long pipe line this additional water causes more surging, more friction drop, with little or no increase of actual power; and it is the writer's firm belief that in all such cases the turbines should be rated as at their full power output where the efficiency is only slightly less than the maximum and the motion of the water-wheel gates should be limited in an unchangeable way so that they cannot be opened beyond this point. This conclusion has been reached as the result of the study of many designs where long pipe lines and surge tanks have been used.

The flywheel effect of the rotating parts is an important factor in regulation, and the ability to store energy in this way as the speed slightly rises and to release energy as the speed falls off, furnishes a time element in which the flow of water in the penstock may be partially or completely readjusted to the new demand of the load. It is the writer's belief that even this well-known feature has not always received sufficient attention and that the regulation of many plants could be materially improved by the addition of heavy steel flywheels.

It is the present purpose, however, to dwell more particularly

upon the function of the surge tank, the correct design of which is probably the most potent factor in promoting proper regulation.

The function of a properly designed surge tank is complex. It may be said to have six distinct duties:

1 To regulate the pressure, preventing undue rise or fall following sudden motion of the water-wheel gates
2 To act as a reservoir furnishing water promptly to the wheel when a sudden demand is made for more, thus taking care of the time element in which the water in the long conduit may be accelerated
3 To lengthen the period of oscillation of a surge so that the governor may prove fast enough to follow it with the gate motion in order to keep the power output of the unit at constant value
4 To damp out this surge vibration in spite of the augmenting effect of the governor action, so that the variation of pressure will not continue to increase after having once been started in oscillation

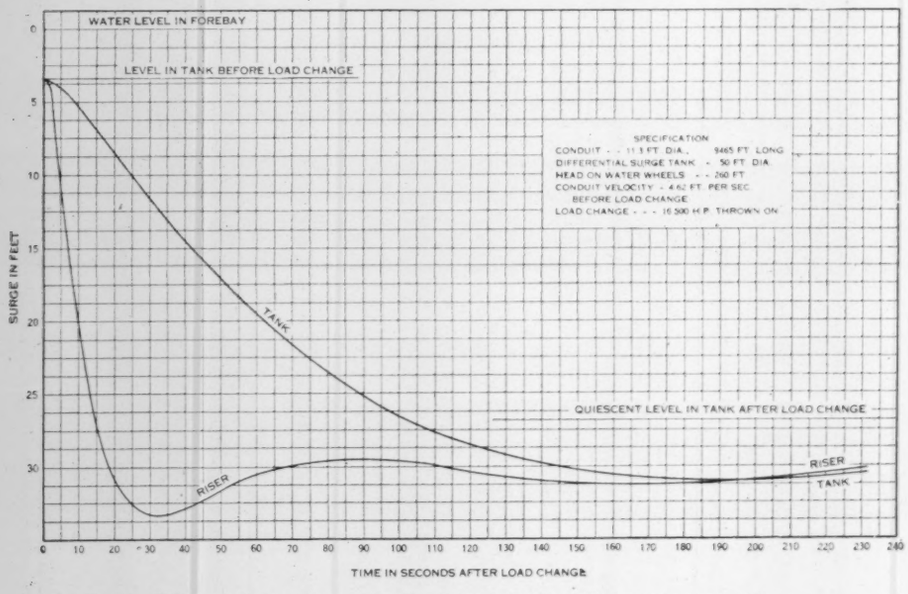

WATER LEVEL IN FOREBAY
LEVEL IN TANK BEFORE LOAD CHANGE
SPECIFICATION
CONDUIT - - 11.3 FT. DIA., 9465 FT. LONG
DIFFERENTIAL SURGE TANK - 50 FT. DIA.
HEAD ON WATER WHEELS - - 260 FT.
CONDUIT VELOCITY - 4.62 FT. PER SEC. BEFORE LOAD CHANGE
LOAD CHANGE - - - 16 500 H.P. THROWN ON
TANK
QUIESCENT LEVEL IN TANK AFTER LOAD CHANGE
RISER
RISER
TANK
SURGE IN FEET
TIME IN SECONDS AFTER LOAD CHANGE
0 5 10 15 20 25 30
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240

Fig. 2 Typical Variation of Water Level in Both Tank and Standpipe of a Differential Regulator

5 To furnish sufficient internal resistance to accomplish this damping effect without depending upon excessive friction in the water system itself which would also assist in this duty
6 To conserve water which would otherwise be wasted in overflow or through a by-pass.

An ordinary standpipe of somewhat large dimensions is frequently designated as a simple surge tank. Its action may be likened to one leg of a U-tube filled with fluid; that is to say, the forebay and pipe-line system, together with the surge tank, form a hydraulic pendulum in which an oscillation when once started by a change of load tends to maintain itself indefinitely, as a pendulum, until the action of friction stops it.

It is plain to be seen that the worse the design of the plant and the more the power which is thrown away in friction, the less likelihood there is of troublesome conditions due to oscillation.

When the waterways are comparatively free from friction, a simple surge tank, such as above described, designed to operate properly, will have to be very large and expensive. This is due principally to the fact that the operation of the governor is such as to keep alive any oscillation which is once initiated.

That is to say, as the water level is dropping due to a load demand, the head is also falling off and the wheel gates must continue to open wider and wider in order to maintain a constant power output of the unit. This calls for more and more water as the level drops and very materially increases the magnitude of the surge; and conversely, as the water rises, the wheel gates must continually decrease their opening for the same reason, and thus fan the surge wave into lively activity.

In other words, the simple surge tank is not, properly speaking, a regulator at all, because it depends upon an undesirable and unnecessary amount of friction to make it work right.

It is of course, a fact that some plants are operating under such conditions and oftentimes without a suspicion on the part of those associated with them that any material improvement would be possible; but a close scrutiny of many of them shows that were it not for almost inexcusably large losses of head, the surge tank, as installed, would not only *not* be a benefit, but would even prove to be a source of danger.

To obviate this difficulty and to provide a regulator which will permit the utmost smoothness of all the waterways, the differential surge tank (see Fig. 1) has been devised. This is really a double tank—the smaller one in the nature of a standpipe freely connected to the conduit and surrounded by another tank which is connected to the conduit by means of a restricted passage. The action of the internal standpipe is very much the same as that of the ordinary standpipe, except that as the water tends to rise or fall its motion is checked by secondary escape of water through the restricted passage into or out of the larger tank. This produces a differential, non-periodic action which is absolutely effective in steadying down any tendency toward instability of the surge wave; and furthermore, inasmuch as the motion of the water within the smaller pipe is relatively rapid as compared to what it would be in a larger simple surge tank, an accelerating head is rapidly applied to the conduit and less water has to be supplied or received than in the case of a simple tank of corresponding dimensions.

Fig. 1 illustrates the relative sizes of simple and differential surge tanks for a given case. In general it may be said that the ratio of the two sectional areas will vary from about two to nearly four, depending upon the physical conditions to be met.

Fig. 2 illustrates the typical variation of water level in both the tank and standpipe (or riser) of a differential regulator. The comparatively sudden drop in the riser level starts immediately an active acceleration of the water column leading from the forebay and, meantime, the lack of water which is only gradually provided through the conduit, is supplied by the tank, thus producing the upper curve.

In about 190 seconds, as shown by the diagram, these two levels come together, which indicates that at that time the conduit velocity has received sufficient acceleration to supply the new demand for water and no further depression of level takes place.

The water level will eventually become quiescent with no further load change, at the elevation shown on the diagram, and if one considers the small distance between this level and the point where the curves cross as compared to the distance up to the level before the load change, it will become apparent how little life is left in this wave.

In other words, the level in this case has not dropped a great deal below the point where the end of the new hydraulic gradient would, in any event, require it to go.

If it should seem desirable to have these two curves cross exactly at the final quiescent level, this could easily be done by making the regulator slightly larger, in which case there would be no surging whatever. That is to say, there would be no motion in the water greater than that which is inevitable on account of the fact that the larger draft of water requires a greater drop in the hydraulic gradient.

This absolute damping of deadbeat effect can also be obtained by means of a simple surge tank, but in that case the area has to be nearly four times as great.

(*Continued on page 248*)

Measuring Water Flow for Power Purposes

Description of a New Method and Its Application in the Efficiency Tests of the 37,500-Hp. Turbines of the Niagara Falls Power Company

By N. R. GIBSON,[1] NIAGARA FALLS, N. Y.

THE necessity of measuring the flow of water used for power purposes at Niagara Falls is known to all who are familiar with conditions there, but many others would imagine that with the whole Niagara River to draw from the consumption of water would be the last thing to consider. On account of the restrictions placed by law upon the diversion of water for power purposes from the Niagara River, however, the measurement of the quantity of water used in the various power plants is a matter of extreme importance. According to the terms of a treaty between the United States and Great Britain, each country is permitted to divert for power purposes a certain quantity of water. In the United States this quantity is 20,000 cu. ft. per sec. and the Niagara Falls Power Company's allotment is 19,500 cu. ft. per sec. The terms of this treaty are being rigorously observed, and in the observance the output in kilowatts of the power company's plants must not at any time exceed the capacity which will utilize its allotted quantity of water.

To determine the relation between power and discharge of a unit it becomes necessary, therefore, to measure the quantity of water used and incidentally to determine the efficiency of the turbine. The importance of this measurement and the accuracy desired will be appreciated if the annual value of the power that can be produced from one per cent of the water allotment is computed. One per cent of 19,500 cu. ft. per sec. would generate in the existing plants at least 4000 hp., the income from which may be placed at about $80,000 per year. On the one hand, therefore, if the allowed capacity were one per cent less than the correct value, the company would be deprived of the possibility of earning about $80,000 per year, and on the other hand if the allowed capacity were one per cent greater than the correct value, it would be able to receive revenue in the same amount in excess of that to which it was legally entitled. The burden of proof, of course, is placed on the power company, and rightly so.

When the three new 37,500-hp. turbines were installed and ready for operation the company was then in a position to use all the water to which it was entitled and the regulating authorities fixed the efficiencies of the new units at a point which it was believed would not be greater than the actual efficiencies. Possibly the efficiency was fixed low enough to make it worth while for the company to go to the expense of proving the exact efficiency. In any event the results were not disappointing because after making the official tests, which received the approval of the division engineer, the allowable output from the three units when charged with the same quantity of water as formerly was increased by nearly 5000 hp.

Shortly before these units were installed the writer had invented a new method of flow measurement which seemed to offer many advantages, particularly in the case of very large units supplied with water through closed conduits. This method was the outcome of studies of the changes of pressure in penstocks caused by the gradual closing of turbine gates which appeared in the form of a paper in the Proceedings of the American Society of Civil Engineers in April 1919. The company is fortunate in having in Mr. John L. Harper a chief engineer of broad vision and unlimited courage, so when the new method of measurement was proposed to him it received at once his full support, and the writer was given an opportunity to develop the method and apparatus for its application.

The method makes use of two well-known principles, the first being Newton's second law of motion, sometimes referred to as the equation of impulse momentum, and the second being a corollary of the first, namely, the relation between change of pressure and change of velocity of a column of water expressed in terms of the velocity of the pressure wave. The application of these two principles makes it possible to determine the mean velocity of a column of water in a penstock by recording the changes of pressure at a point in the pipe line when the flow of water therein is gradually brought to rest by closing a valve or the turbine gates. The mean change of pressure so recorded is a precise measure of the velocity destroyed.

In practical work it is not always possible to stop the flow entirely, because leakage nearly always occurs through the turbine gates, and in such cases the velocity determined is the difference between the initial and final velocities. The remainder is readily determined in one of several ways.

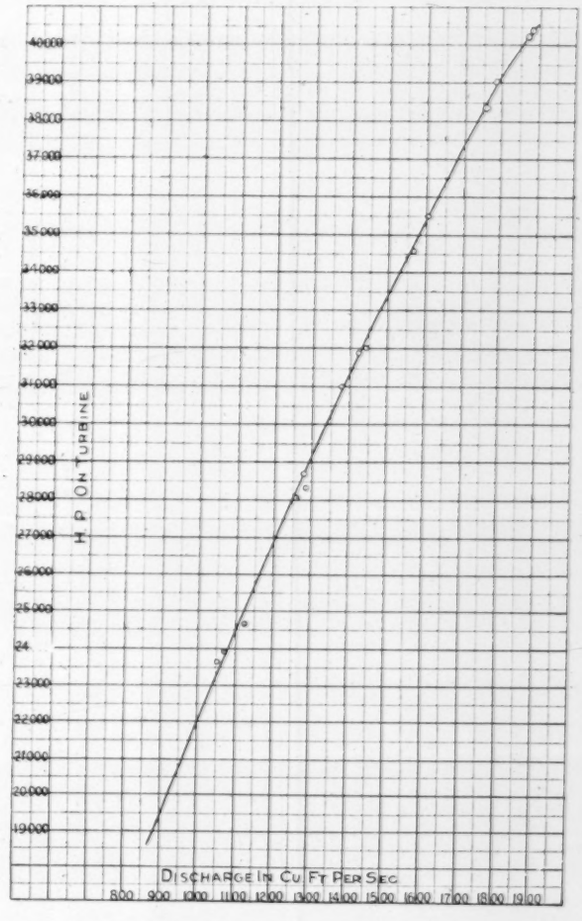


FIG. 1 POWER-DISCHARGE CURVE FOR UNIT NO. 18 OF THE NIAGARA FALLS POWER COMPANY

The apparatus employed comprises a new combination of simple elemental parts in which the pressure element is a U-tube containing mercury, the motion of which can be made to correspond in any desired ratio to the change of pressure in the penstock. The apparatus provides illumination and records photographically to exact full scale the motion of the top surface of the mercury in the tube and combines in the record the oscillations of a seconds pendulum. The resulting diagram shows to exact scale a complete record of pressure changes and time.

After completing the theoretical studies and after building the

[1] Hydraulic Engineer, Niagara Falls Power Company.

Abstract of a paper presented at the Symposium on Hydroelectric Development and Distribution, held at Philadelphia, January 21, 1921, under the auspices of the Engineers' Club of Philadelphia and the Philadelphia Sections of the American Society of Civil Engineers, the American Institute of Electrical Engineers, and The American Society of Mechanical Engineers.

first apparatus, which has subsequently been much improved, both theory and apparatus were tested by experiments.

One of the most important reasons why it was desired to use the new method rather than one of the older and well-known methods, was that tests could be carried out without serious or prolonged interruption of the supply of power from the unit being tested. It requires a two-minute shutdown for each measurement, and the measurements may be repeated about once every ten or fifteen minutes. A complete set of measurements at each tenth gate opening from half to full gate may be made in less than two hours, and during that time the unit would be out of commercial service only about fifteen minutes.

There were two other reasons that may be mentioned, one being that the trouble and expense of the tests would be much less than by any other method, and the other that it was believed the new method was very accurate.

Without going too deeply into theory, the reason for the accuracy of the new method will be appreciated by a reference to the fact that a small change in velocity can be made to produce a relatively large change of pressure. The mean change of pressure corresponding to a change of velocity can be made from five to twenty times the velocity head or even greater if there were any advantage in doing so. In the pitot tube the velocity head only is observed, or, at best, by differential methods only some small multiple of it. In the new method a record is made with great precision of a quantity that is many times greater than the velocity head. In other words, the quantity observed and recorded is many times greater than, but is proportional to, the quantity it is desired to know. It is true, of course, that this change of pressure takes place in a comparatively short time, and the element of time must be considered. It is comparatively easy, however, to measure time very accurately. If an interval of ten seconds is measured within one-tenth of a second, the error is only one per cent, but time may be quite readily measured within one one-hundredth of a second, in which case the error is only one-tenth of one per cent. It so happens, however, that in the new method it is not necessary to measure time directly at all, but only the product of pressure and time, which may be done very accurately indeed.

In order to obtain satisfactory proof of the accuracy of the new method of measurement, as required by the authorities in charge of the regulation of the use of the water, arrangements were made with Dean E. E. Haskell, of the College of Civil Engineering at Cornell University, to have a thorough test made by comparison with volumetric measurement at the laboratory of the university. Six series of tests were made under conditions approximating as nearly as could be had at the laboratory, the conditions prevailing for efficiency tests at Niagara Falls. Table 1 shows the results of the nineteen tests made, from which it is seen that the average of all measurements made by the Gibson method agrees within less than two-tenths of one per cent with the average of all the volumetric measurements. The maximum variation of any one series is eight-tenths of one per cent.

A very careful analysis of these results has been made, which indicates that part of even the slight variations between the volumetric measurements and measurements by the new method may be explained by a very slight unsteadiness of flow, which is sufficient to account for some of the difference between the two measurements. This unsteadiness seems to be characteristic of all water flowing above the critical velocity, and while difficult to account for, it was manifest in this case by the variations in the level of the water passing over the weir before it entered the measuring tank. The magnitude of the variations in gage height was an index of the magnitude of the variations in flow. It would be natural of course that variations in the measurements due to this cause would be both positive and negative, and the mean of a series of results would not show differences of the same magnitude as might occasionally be found in any single measurement. The fact that the mean variation between the volumetric measurements and the measurements by the new method is only two-tenths of one per cent would indicate that, while there might be a difference between the two methods of measurement for any one observation, each method might be as near perfect as the other, because the quantity measured is slightly different in each case.

Having thus established, by careful experiments, the accuracy of the new method, the official efficiency tests of the before-mentioned three new units in Station No. 3 Extension were made on June 29, August 8, and August 17, respectively. On account of the ease with which diagrams can be made, several were taken at each gate opening so as to obtain an average result, and in all from sixteen to eighteen diagrams were made for each unit.

After velocities had been calculated from the diagrams and discharges, and effective heads computed, the usual power-discharge and efficiency curves were prepared. Fig. 1, which is representative, shows the remarkable uniformity in the determination of the points along the power-discharge curves, from which it may be concluded that the errors of observation, or so-called variable errors, are extremely small. The absence of any inherent or consistent error was demonstrated by the tests made at Cornell University.

TABLE 1 COMPARISON OF VOLUMETRIC MEASUREMENTS WITH THOSE MADE BY AUTHOR'S METHOD

Date 1920	—Discharge— (cu. ft. per sec.) Volumetric	Gibson	Per cent variation	Remarks
June 11	20.27	20.31	+0.2	Tube R = 1.335.
June 11	20.42	20.52	+0.5	
June 11	20.45	20.65	+0.9	
	20.38	20.48	+0.5	Mean of series.
May 24	30.38	30.51	+0.4	
May 25	30.63	....	....	Poor diagram (not completed)
May 25	30.69	31.15	+1.5	
	30.57	30.82	+0.8	Mean of series
May 25	42.24	42.17	−0.2	
May 25	41.94	42.28	+0.8	
May 25	42.22	42.09	−0.3	
May 25	....	41.96	....	Volumetric not taken.
	42.13	42.12	0.0	Mean of series.
June 4	40.36	40.41	+0.1	
June 4	40.36	40.90	+1.3	
June 5	40.98	40.88	−0.2	
	40.57	40.73	+0.4	Mean of series.
May 29	46.82	....	....	Film fogged, diagram invisible
May 29	46.95	46.60	−0.7	
May 29	46.98	46.60	−0.8	
	46.92	46.60	−0.7	Mean of series.
June 7	50.30	49.95	−0.7	
June 9	50.66	51.47	+1.6	
June 10	50.93	51.15	+0.4	
	50.63	50.85	+0.4	Mean of series.
Total of Means	231.20	231.60	+0.2	Mean variation of all tests.

In conclusion, attention may be drawn to some of the advantages of the new method of measurement where it may be applied:

1 Remarkable accuracy in the determination of the velocity of flow because small changes of velocity result in comparatively large changes in the pressure to be recorded.

2 Determination of velocity may be made without serious or prolonged interruption of the commercial supply of power from the unit being tested.

3 Each determination of the velocity of flow may be made quickly in one operation, tedious methods involving tabulation of observed results being avoided.

4 The process is essentially simple and inexpeasive. Special appurtenances in the pipe line are not required.

SPEED REGULATION OF TURBINES

(*Continued from page 246*)

Where large tanks have to be supported on towers, if the differential action is not resorted to, the dimensions of a simple tank will be such as to make its construction impossible on account of exceeding the limits of the boilermaker's art in respect to thickness of plate, size of rivets, etc., where most of the assembling must be done in the field.

Merely because a water-power plant is in successful commercial operation, is by no means an indication that it is doing nearly its best. It seems rather remarkable that while great attention is usually paid to the question of high efficiency of the water wheels and generators and much effort is expended to gain the last one-half of one per cent, enormously larger losses are sometimes permitted to accumulate in the water system, which, by reason of their not having been definitely located or computed, never cause the slightest concern to the financial interests.

Principles of Industrial Philosophy

By WALTER N. POLAKOV,[1] NEW YORK, N. Y.

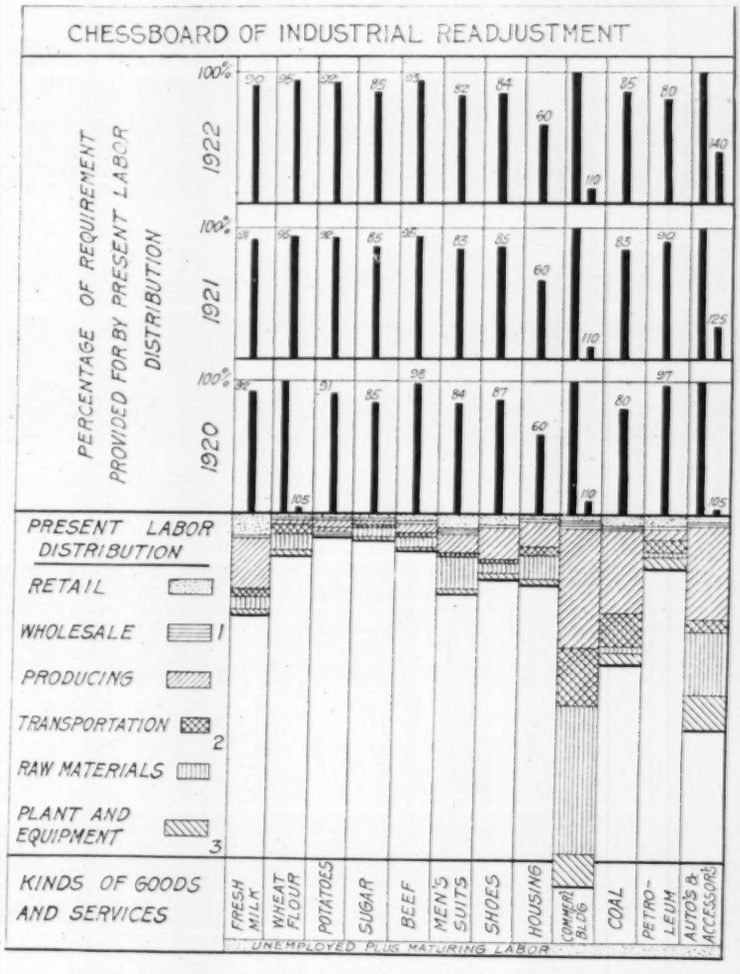
THE arrogance of dogmatism has been recognized from the days of Francis Bacon and Réné Descartes as a chief cause of the retardation of human progress. Dogmatism is by nature conservative since it is based upon *information obtained in the past* and upon *beliefs* formed by frequent repetition of dogmas; and inasmuch as conservatism is an element of dogmatism, it is therefore of necessity arrogant. Its method of self-preservation is to prevent the verification of truth by experiment with facts. Wars and revolutions do not happen—they are caused by arrogance of conservatism based on insufficient knowledge of the laws governing human development.

Self-assumed authority and unanimity, upon which human relations are formulated (commonly known as autocracy and democracy) are conservative in so far as they are based upon beliefs accepted in the past. Their preservation depends upon legal opinion and police force. Opinion derived from an accepted dogma (through scholastic speculation) is impotent to discover new truths, while the power of police force is exercised to suppress their manifestations.

As opposed to this *static* character of social relations, there is produced the *dynamic* force of the economic, intellectual, and spiritual relation through the accumulation of a mass of positive knowledge which gains momentum through a period of time. The gap between the two has been increasing at an accelerated rate until now the old social relations are collapsing and new dogmas are being formulated corresponding more closely with the existing state of technique. Thus in social relations we observe revolution, while in economic and spiritual we have evolution.

The conflict of static control and dynamic process is peculiar only to human life. Prehistoric bees and ants performed their work in a manner identical with ants and bees of today. No expert bee taught posterity how to produce more honey in less time; no expert ant trained the rest of them how to build hills quicker and with less exertion.

On the other hand, the "binding time capacity of the human class of life" has been an unconscious force working toward progress and improvement. Its impulse has been to seek, to learn and to teach how to produce greater results in less time, thus saving the time allotted us to live. The fundamental law of the human class of life is binding time, the natural expression of which is the rendering of service by past generations to posterity. "Survival of the fittest" as an expression of the animal law of self-preservation has its counterpart in the "human class of life" in the "survival of service in time" as an expression of the human law of "binding time." This capacity of humans to "bind time" and thereby to accumulate a wealth of knowledge, like any natural organic capacity is insuppressible, as has been demonstrated for the first time by A. Korzybski in his forthcoming book Human Engineering. The suppression or interference with the exercise of this potential power creates counteraction, with consequences as disastrous as an interference with any other known law of nature.



EXAMPLE OF USE OF GANTT'S METHOD IN ANALYZING INDUSTRIAL READJUSTMENT

THE PHILOSOPHY OF H. L. GANTT

Gantt's philosophy was formulated with an understanding of this first law of human life and can neither be disputed nor ignored. Its application to human relations, and more specifically to industrial problems, is as inevitable as the application of the law of gravitation to astronomy with certainty in foreseeing the results. The method of application of this philosophic concept to the solution of practical problems determines what these results are to be in the same manner as in the solution of a mathematical problem, where an error in the answer is not due to any fallacy in the principles themselves but rather to the method of application of the principles. As formulated by Gantt, the "business system had its foundation in service, and as far as the community is concerned, has no reason for existence except the service it can render."

The foundation of our economic, industrial, and business system lies in the service rendered by all the preceding generations of humanity. A sewing machine is capable of increasing the productivity of its operator not only by the amount of labor worked into it by the mechanic who made it, but by the integrated services of all the scientists, philosophers, artisans, etc., and of all those who since the ages of primitive men have served indirectly to make their lives and works possible. If this were not so, the increased productivity of an operator using a machine would be equal only to the productive efforts expended in its construction. The law of Mayer and Lavoisier, that energy and matter cannot be created or annihilated, would receive its death blow by the first yard of stitches made on the machine in excess of the energy expended by all the living coöperating workers.

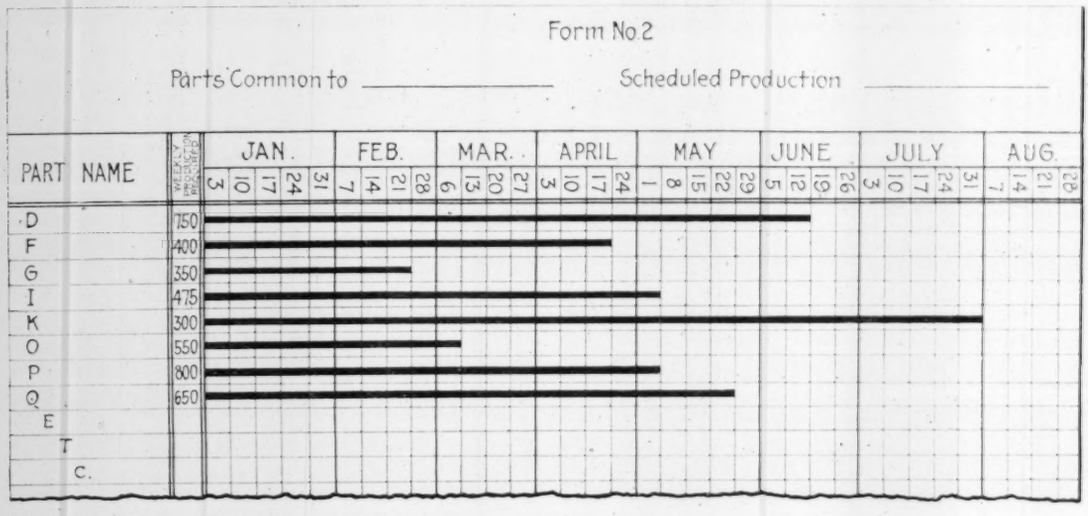
The law of nature remains inviolated, however, for the "time-saving" capacity of machines is the manifestation of the service of dead men, who passed to us their ideas and knowledge. This ever-increasing accumulation of our material and spiritual wealth

[1] Consulting Engineer, Walter N. Polakov & Co., Inc., Mem. Am.Soc.M.E.

Paper presented at the Annual Meeting, New York, December 1920, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. All papers are subject to revision.

is therefore not so much the fruit of our toil as that of preceding humanity. Wealth, therefore, like knowledge, if treated as personal property, loses its human value, for possession is an animal standard which is based on "binding space"—brute force of dogmatism—and not on the human capacity of "binding time."

The neglect to abide by and to live up to this natural law of humanity was in Gantt's mind when he said: "The production of goods was always secondary to the securing of dollars." This is evident from a study of our economic development which is characterized by periodic crises, that is, business depressions, financial panics, and overproduction for profit, not for use. To use Gantt's analysis: "If we could harvest more dollars by producing fewer goods, we produced fewer goods. If it happened that we could harvest more dollars by producing more goods, we made an attempt to produce more goods. To be sure, the relation between the demand for, and supply of, the product, directed by a desire to get the greatest possible profit, has resulted in a sort of control which has usually been based more on opinion than on facts, and generally exercised to secure the greatest possible profits rather than to render the greatest service." This violation of the natural law of humanity, that is, the substitution of an *animal* aim of selfish profit for the *human* aim of "binding time" by means of rendering service, brings ultimate and unescapable punishment, as does any act contrary to the laws of nature.



IN "THE AMERICAS," MR. ELLERY A. BAKER, OF THE NATIONAL CITY BANK OF NEW YORK, ADOPTS GANTT'S CHARTING MECHANISM, URGING INCREASE OF PRODUCTION (APRIL 1920)

The analysis of law and fallacies brings about a realization of the consequences of violations of this law and introduces a motive into our actions. In Gantt's formulation, "The business system must accept its social responsibility and devote itself primarily to service, or the community will ultimately make the attempt to take it over to operate in its own interest." The social experiments conducted in Russia, Italy, and less systematically in Germany, England, and Austria, are ample proof that the operation of this law is as infallible, unavoidable, positive, unalterable, and universal as that of any natural law.

The conflict between the animal standards of business and the human standards of science and technology has recently culminated in the World War and subsequent revolutionary movements. The enormous power which the application of technology gives to the conservative, dogmatic rule of static animal instincts, brought about a realization of the necessity for wise direction of the dynamic forces of society. The direction of any force presupposes an understanding of laws which it follows. Until Gantt postulated the fundamental law and showed its application to be technology, this accumulated wealth of all preceding human generations remained a blind, unconscious, aimless force, beneficial or destructive as the whim of dogmatic speculation decreed.

Engineering has been variously defined according to the private opinion of scholastic minds: from the *moral* viewpoint as the "mastering of natural forces and materials for the benefit of mankind;" from the *economic* viewpoint as "engineering aims at maximum production with minimum outlay of time, efforts and resources;" or from the *utilitarian* viewpoint as "knowledge of what to do, when to do it and how to do it." Such statements demonstrate vague and arbitrary selection of aims. Now, technology, and more specifically engineering, can be defined as "a method of rendering rigorous service."

The direction of the enormous forces of technology of modern society according to static dogmas which violate the natural law of human developments, can result only in the destruction of society. Until this fundamental truth was conceived, the privilege of violating this law of humanity had its origin in ignorance. The forbidden fruit of the Tree of Knowledge was eaten before it was ripe and mankind suffered from mental indigestion until the Nazarene brought His gospel of a "chief that doth serve." For two thousand years this revelation has been dogmatized and kept out of practical application by those more willing to receive than to give service.

Using the Baconian method of induction and the Cartesian method of doubt in his confutations of economic and industrial fallacies, Gantt began with expositions of errors, proceeded with producing evidence of the causes of error, and concluded with the establishment of verified truth.

With the projection of service through time established as the natural law of humanity, the criterion for human activities suggests itself as a necessary and sufficient corollary: "In an economic or a moral sense an action is right when it will advance the cause of humanity, and wrong when it will not."[1]

Following up the mathematical method of reasoning, human relations, periodically clashing in disastrous catastrophes, present a problem consisting "in a readjustment of our economic conditions with the object of averting another such catastrophe." Such a readjustment obviously must be in compliance with the fundamental principle of human progress. The first practical task, therefore, is the exposition of error.

Gantt produced the evidence of the causes of errors from the analysis of social evils which lead the so-called civilized world periodically to such catastrophes as overproduction coincident with unemployment, epidemics, high infantile mortality, underfed school children, etc., or revolutions and wars for new markets after internal markets have been overtaxed, or competition which withholds from competitors information which would make for advancement in art. According to Gantt, industry cannot begin to fulfil its function of serving humanity until we

1 "Eliminate special privileges of whatever kind, and make industry and business serve the community;

2 Base the conduct of industry and business on facts, instead of opinions, as has been common in the past;

[1] Influence of Executives, in Annals of the American Academy of Political and Social Science, publication No. 1319.

3 Put in charge of business and industry men who are capable of understanding facts and of taking proper action in accordance with them, irrespective of whether such men are owners or not."

For the purpose of rendering such service Gantt has established a method and developed the mechanism for its application.

METHOD OF SERVICE

Gantt's method of inquiry into correlation of social needs and industrial services is very close to that laid out by Francis Bacon, Lord Verulam, in his Novum Organum (1620), although his philosophy is nearer that of Descartes. He follows a well-beaten path of scientific analysis in order to eliminate and exclude all elements of doubt and to establish each fact from a sufficiently large number of observations with reasonable certainty. Gantt divides such an investigation into three parts, as follows: "An analysis of the operation into its elements; a study of these elements separately; a synthesis, or putting together the results of our study." Practice of this method leaves no room for opinions, frequently dignified by the name "theories."

Heretofore this method has been employed by every positive science and has transformed witchcraft into medicine, alchemy into chemistry, astrology into astronomy, and craftsmanship into engineering. Those lines of human endeavor that failed to adopt this scientific method remained in the medieval state of dogmatic sophistry like jurisprudence, which even in the twentieth century renders such decisions as the acquittal of a man charged with bigamy on the ground that his first wife is under legal age, hence he is not legally married to her.

This method of scientific research while in itself not new, was extended and applied by Gantt to decidedly novel purposes. It was applied to engineering rendering rigorous service to society and to the measurement of the service rendered. Heretofore profit-making managements, which aimed at converting industry into a dividend-grinding mechanism, have attempted to use scientific methods. From now on the achievement of Gantt offers a means of measuring the human or social efficiency of industry. Special privileges and incompetency are no longer a matter of private or prejudiced opinion, for by means of quantitative analysis they can be ascertained and measured with precision like any other physical phenomena. Gantt's method has made it possible to ascertain the cause of the diseased industry just as blood analysis established the cause of malaria. While the latter made the completion of the Panama Canal possible, the former will transform industry from servitude into creative service and its pensioners into respectable members of the community.

A criticism is sterile unless it carries the constructive element. The mechanism for demonstrating the results of the analysis is at once the mechanism for directing the service. The mechanism of Gantt for the analysis of service exposes error in a manner clearly indicating its cause. He who knows the cause of his failure can readily avoid failure unless he is mentally defective or criminally inclined. Graphic presentation of failures in production, distribution, etc., is as immediate in effect as it is obvious. Unlike statistical diagrams, curve records, and similar *static* forms of presenting facts of the past, charts logically evolved from the concept of "binding time" by rendering service are *kinetic*, moving, and project through time the integral elements of service rendered in the past toward the goal in the future.

Three cardinal questions asked of industry, agriculture, transportation or any other productive endeavor, are:

1 Is the work progressing in time as rapidly as necessary? If not, why not?

2 Are the means of production serving the productive purpose? If not, why not?

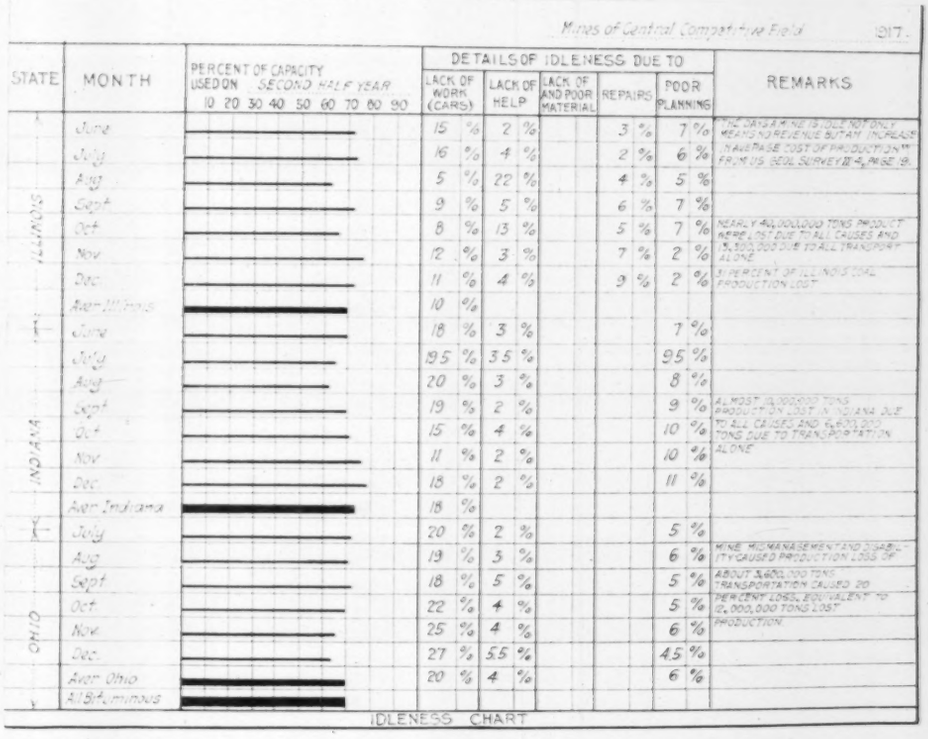
3 Are the time and skill of those engaged applied to rendering service? If not, why not?

The answers to these inquiries, secured with the aid of scientific analysis, solve the problem of rendering rigorous service. This method simultaneously produces secondary effects in strict conformity with the fundamental law of rendering service for the benefit of humanity, inasmuch as:

1 Facts being established leave no room for opinions, traditions, or fallacies

2 Facts being openly established, privilege supported by secrecy fall.

3 Facts being public, drive into disrepute incompetence, bluff, nepotism and favoritism


Mines of Central Competitive Field 1917.
STATE
MONTH
PERCENT OF CAPACITY USED ON SECOND HALF YEAR
10 20 30 40 50 60 70 80 90
DETAILS OF IDLENESS DUE TO
LACK OF WORK (CARS)
LACK OF HELP
LACK OF AND POOR MATERIAL
REPAIRS
POOR PLANNING
REMARKS
ILLINOIS
June 15 % 2 % 3 % 7 % "EC DAYS A MINE IS IDLE NOT ONLY MEANS NO REVENUE BUT AN INCREASE IN MAINTENANCE COST OF PRODUCT PER TON" FROM U.S. GEOL SURVEY BULL 694, PAGE 19.
July 16 % 4 % 2 % 6 %
Aug 5 % 22 % 4 % 5 %
Sept 9 % 5 % 6 % 7 %
Oct 8 % 13 % 5 % 7 % NEARLY 40,000,000 TONS PRODUCT WERE LOST DUE TO ALL CAUSES AND 14,500,000 DUE TO ALL TRANSPORT ALONE
Nov 12 % 3 % 7 % 2 %
Dec 11 % 4 % 9 % 2 % 31 PERCENT OF ILLINOIS COAL PRODUCTION LOST
Aver Illinois 10 %
INDIANA
June 18 % 3 % 7 %
July 19.5 % 3.5 % 9.5 %
Aug 20 % 3 % 8 %
Sept 19 % 2 % 9 % ALMOST 13,000,000 TONS PRODUCTION LOST IN INDIANA DUE TO ALL CAUSES AND 4,600,000 TONS DUE TO TRANSPORTATION ALONE
Oct 15 % 4 % 10 %
Nov 11 % 2 % 10 %
Dec 18 % 2 % 11 %
Aver Indiana 18 %
OHIO
July 20 % 2 % 5 %
Aug 19 % 3 % 6 % MINE MISMANAGEMENT AND DISABILITY CAUSED PRODUCTION LOSS OF
Sept 18 % 5 % 5 % ABOUT 3,600,000 TONS TRANSPORTATION CAUSED 20 PER CENT LOSS, EQUIVALENT TO 6,000,000 TONS LOST PRODUCTION.
Oct 22 % 4 % 5 %
Nov 25 % 4 % 6 %
Dec 27 % 5.5 % 4.5 %
Aver Ohio 20 % 4 % 6 %
All Bituminous
IDLENESS CHART

IN *The Dial* (NOV. 1, 1919) DATA OF U. S. GEOLOGICAL SURVEY, BUREAU OF MINES, FEDERAL TRADE COMMISSION, ETC., ARE STUDIED AND REPRESENTED BY MEANS OF MR. GANTT'S METHOD

4 Results being compared, point out where most service and help is needed

5 Results attained being known, create interest in the work and bring commensurate reward

6 Attainment of the aim being recorded, stimulates rendering service.

Moreover the proper use of such mechanism points out three integral elements of the organization for rendering rigorous service, namely,

1 Reward commensurate with service rendered

2 Elimination of idleness before securing additional means of production

3 Utilization of available knowledge without awaiting the new discoveries.

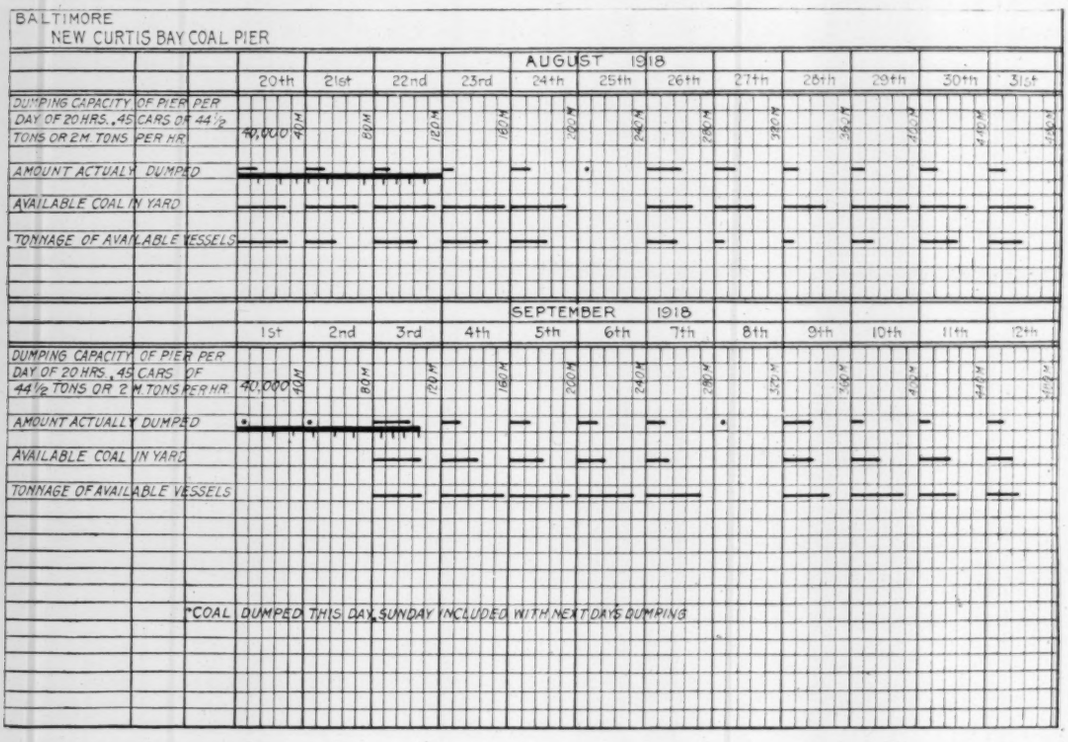
The strict conformity of the above aphorisms with the fundamental postulate renders them an organic whole as irrefutable as the natural law of binding time for the human class of life.

APPLICATION AND INFLUENCE OF THE PRINCIPLES ENUNCIATED BY GANTT

The sphere of application of the principles of Gantt is limited only by the boundaries of human activities. Not every act that is performed within *time* at an expense of *energy* (whether mental or physical) falls into the class of "binding time." The applica-

tion of the criterion of projection of service through time or real "binding time" defines whether or not the act is of human dimension. An act possessing zero or negative value from the point of projecting service into future time has no human value. The inexpert waste of natural resources which is present in the consuming of time and destroying of energy through misdirected effort is contrary to the "natural law of the human class of life" because it renders a negative service to future mankind.

Similarly a war or other form of securing profit at the expense of destruction is a violation of the law of humanity. Again, activities that merely keep things in balance, consuming what is produced without serving futurity, as for instance those of mere maintaining animal existence, are of no human value. On the other hand, service which tends to accumulate and augment the time value, like that of increasing knowledge which will be of service in the time to come, is human and positive. A few illustrative examples of the influence of this philosophic concept and recent applications of Gantt's method to various problems are given in the five accompanying charts.


BALTIMORE
NEW CURTIS BAY COAL PIER
AUGUST 1918
20th 21st 22nd 23rd 24th 25th 26th 27th 28th 29th 30th 31st
DUMPING CAPACITY OF PIER PER DAY OF 20 HRS. 45 CARS OF 44½ TONS OR 2 M. TONS PER HR.
40,000 40M 80M 120M 160M 200M 240M 280M 320M 360M 400M 440M
AMOUNT ACTUALLY DUMPED
AVAILABLE COAL IN YARD
TONNAGE OF AVAILABLE VESSELS
SEPTEMBER 1918
1st 2nd 3rd 4th 5th 6th 7th 8th 9th 10th 11th 12th
DUMPING CAPACITY OF PIER PER DAY OF 20 HRS. 45 CARS OF 44½ TONS OR 2 M. TONS PER HR.
40,000 40M 80M 120M 160M 200M 240M 280M 320M 360M 400M 440M
AMOUNT ACTUALLY DUMPED
AVAILABLE COAL IN YARD
TONNAGE OF AVAILABLE VESSELS
*COAL DUMPED THIS DAY, SUNDAY INCLUDED WITH NEXT DAYS DUMPING

During the War the Critical Coal Situation was Similarly Studied by Government Agencies by Following the Path Blazed by Mr. Gantt. This Chart Shows Neglect to Use our Coal-Loading Capacity

The influence of this philosophy is clearly shown in the recent conception of credit as a measure of the ability to render service (human standard) as opposed to the earlier practice of extending credit commensurate with the possession of things (animal standard), as well as in the still more recent recognition of the accountability of public utilities for their waste of natural resources.

The acceptance of the new concept is evolved in the change of our social and industrial relations from the régime of ignorant violation of the natural law of humanity for the projection of service into the future, to that of compliance with this law. Heretofore the success of an undertaking was measured in dollars. Improvements were reckoned in dollars saved. The stability of the enterprise was dependent on the steady flow of dollars. Quality of the product had value in so far as it permitted a larger margin between the price and production cost. Wages were fixed at the lowest acceptable minimum. Working hours were limited only by need for recuperation. Hygiene and safety were judged from their effect on dividends. Human relations were considered only when dollars were in danger. Natural resources were sacked, for it paid better to waste than to conserve. Outputs were determined only by the ability of the customer to buy, and not by his need. Idleness was respectable—it gave leisure to a few who could enjoy it.

The control of resources, of means of production or even of political power is of no avail whatsoever unless the productive forces are so directed and organized that the new industrial relations shall better serve large masses of people. The knowledge and the ability to do things assumes the natural, intrinsic authority and leadership. It is inevitable, therefore, that the industrial administrators, preeminently the engineers, are alone capable of mastering the complex mechanism of modern life in motion. The old masters of static things have no function in the modern dynamic society. The new leadership cannot be either autocratic or arbitrary, for dealing as it does with the laws of nature, with intrinsic laws of life, not with man-made laws of barristers, it can neither alter nor misinterpret them. Where errors spell annihilation, there is no room for opinions, whims or desires. Action must be taken on the basis of the knowledge of facts; hence those who know what to do and how to do it must assume the leadership. Their authority, being based upon the knowledge of facts, cannot be questioned, disputed or denied any more than the facts themselves. This authority is not conferred on them by vote, nor is it taken by force—it is theirs so long as it serves humanity in its quest for life and happiness. The problem therefore resolves itself into the mastering of time, or, in other words, the extension of human life and happiness into the future.

Yet even this aim alone is narrow and unsatisfactory. Mere "avoidance of starvation" appears today, in view of the advancement of science and technology, as an uninspiring daily toil. A higher ideal, a more inspiring aim of self-expression is instilled into the masses of even the most downtrodden people by the retrospect of the past struggle for mere animal existence. The desire to create can no longer be suppressed in the human masses. In factories as in politics it is no longer a full dinner pail that is the goal, but an indispensable means for self-expressive creation, for self-projection into the time to come. This philosophy, as established by Gantt, thus provides means and motives for accomplishing the natural aim of human development, and is bound to play the role of intrinsic leadership, pointing the way out of the welter into which the disregard of the fundamental law of humanity has brought us.

DISCUSSION

At the solicitation of Mr. Polakov a number of discussions of his paper have been presented. It is not possible to publish these in their entirety, but the following selections from certain of them cover the main points which have been brought out.

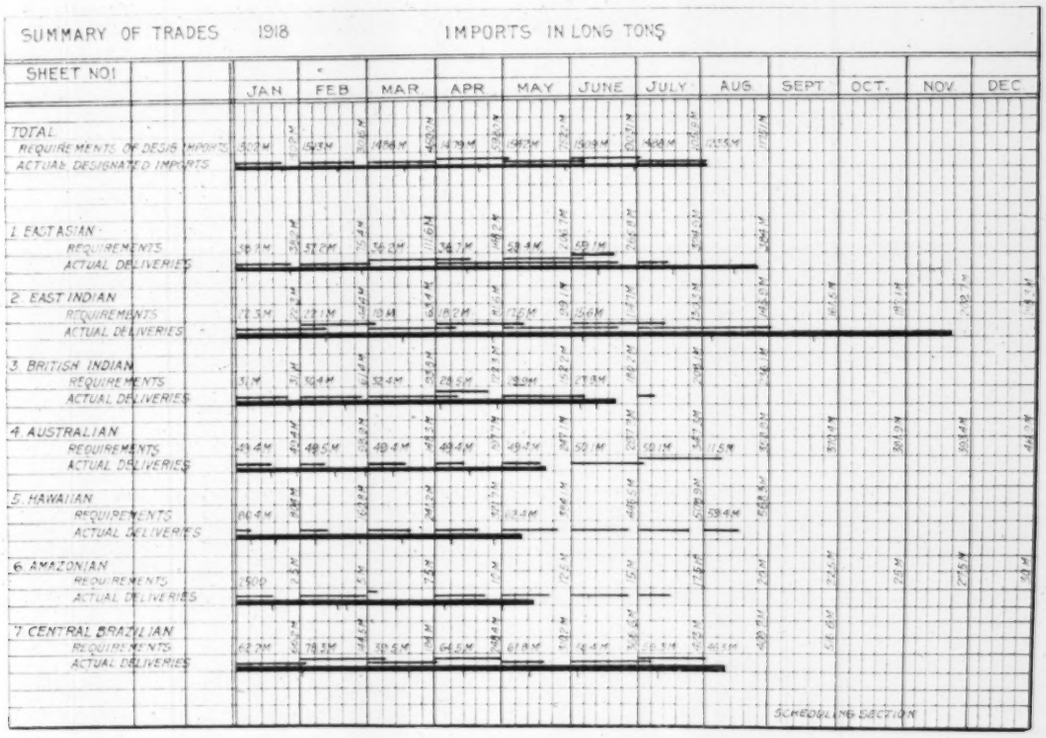
ROBERT B. WOLF. The faculty of recording past events as a guide to future actions is what Mr. Polakov claims to be the secret of the success of Mr. H. L. Gantt's method of recording plant progress by the chart method. These graphical charts make it possible for those in charge to be conscious of a greater portion of the *past* in the *present* than is the case with the old historical or descriptive methods, and it is because of this greater consciousness of past events that the future can be more definitely predetermined. This, of course, results in a maximum of production with a minimum outlay of *time*.

This concept, according to Mr. Polakov, was more specifically indicated by the Polish engineer, Alfred Korzybski, who brings out, for the first time, the outstanding difference between the three kingdoms of the organic world—the vegetable, the animal, and the human.

Having concluded that the function of the vegetable was to "bind energy" and the animal to "bind space," he next turned his attention to the records of human activities. He soon realized that the outstanding characteristic which distinguishes the human being from the animal is its capacity to record past experiments, to make them available for future generations.

All of the world's great religions were based upon the recorded teachings of their founders. Our whole system of law is based upon past precedents recorded in our court proceedings, and modern science is primarily an accurate history of the results of past happenings in the organic and inorganic worlds. It is this recording of events in *time* which is a distinctly human faculty and through it man becomes conscious of the operation of the principle of causation, for without this power of recalling past events man could not have come to a realization of the absolute unchangeableness of natural law.

This faculty of holding or fixing past events to make the knowledge of them a source of power for future generations, is what Korzybski calls "binding time." His third generalization is that man is therefore a "binding time" class of life. The natural effect of this is that each succeeding generation of mankind is able to begin approximately where the preceding one left off, whereas in the animal world each succeeding generation is obliged to begin practically where the preceding one began.



FOREIGN TRADE MAY BE REGULATED BY GANTT'S ANALYSIS AS WELL AS ANY OTHER HUMAN ACTIVITY

It has been my privilege to review Count Korzybski's book and in order to discuss Mr. Polakov's paper intelligently it will be necessary briefly to explain Korzybski's expression "binding time" to which Mr. Polakov makes frequent reference.

Korzybski, who had ample opportunity to observe the destructive effects of commercial competition in Europe, concluded that human standards were but little above the animal standards and that the "survival of the fittest" naturally resulted. It was in the hope that he could find a fundamental distinction between the various classes of life that he began his researches by studying the accumulated records of the past.

He first turned his attention to the lowest form of organic life, the vegetable, and very soon found its main function to be the storing up of solar energy. The vegetable organism, which does not move about, but is attached to the earth, draws up through its roots the inorganic chemical substances from the earth and forms them into a cell in which the energy of the sun is confined. He therefore concluded that the function of the vegetable class of life is to "bind solar energy." Coal, for instance, is of vegetable origin and in burning it we release sun power.

He next directed his attention to the records of animal life and at once noted that the outstanding thing which distinguished it from the vegetable is its freedom to move about in space. As all life proceeds by multiplication, i. e., geometrical progression, each species of animal life was soon in conflict with every other species. This animal characteristic of movement *in* space and occupation *of* space resulted, of course, in a struggle for self-preservation. This was especially true in an environment which stimulated rapid reproduction of the species. Darwin observed this when he enunciated the principle of the "survival of the fittest"—no two physical bodies can occupy the same space at the same time.

These observations led Korzybski to his second generalization, namely, that because of this fundamental faculty of movement in space, the animal was destined to increase its power of movement by its occupation of more space. The animal, he therefore concluded, was a "binding space" class of life.

The far-reaching effects of this new realization of human life are expressed by Korzybski in his conception of what human competition *should be*, namely, *competition in time*—"survival of the fittest"—yes; but in *time*, not in *space*.

Man, therefore, by the basic law of his nature, is compelled to work for posterity. The animal is conscious of only one dimension of time, the present—man alone consciously uses all three: past, present and future. This is why real education, by means of the *true* presentation of the facts of the past, is the only cure for wars; also why humanity must resist any dogmatic attempt to keep the individual in ignorance. Safety lies only in a true evaluation of the past, in order that *present* humanity can consciously create a *future* which will be in harmony with the universal creative purpose.

My intense interest in the subject-matter of Mr. Polakov's paper is the amount of light that this concept of man as a "time binding" class of life throws upon my own past experience.

In Non-Financial Incentives[1] I showed how men invariably put forth their best efforts when furnished with continuous records of past performances. *In all such records the individual competes with his own past and with the past performances of others.* This is the secret of the baseball player's interest in the batting average, for it is only the animal that lives in the present, that competes with the present. Present competition is "space" competition, and therefore destructive.

Intelligent effort is creation, and as no such self-expression can be obtained without some degree, at least, of conscious use of past experience, it follows that this conscious use of time is the very essence of creation. It requires time to create a universe, a garden, or an automobile, and the production records of Gantt show clearly that it is only an efficient *use of time* that makes greatest productivity possible.

Gantt's conclusion that the Golden Rule is the most practical doctrine

[1] Presented at Annual Meeting of A.S.M.E., Dec. 3–8, 1918.

upon which to conduct business, makes an intellectual as well as an emotional appeal, looked at from the point of view of man as a "binding time" class of life, for it is only when every man does to every other man what he would have all men do to him that the human race can make its greatest progress in the *future*.

Judged by the same standard, that other great Christian injunction, "It is more blessed to give than to receive," is recognized to be the *only* practical guide to human life. Getting is "space binding" and therefore animal. Sooner or later our accumulations will conflict with those of others and a physical conflict is inevitable. We must cease our efforts to possess *things* and make *giving, which means rendering service*, our main object in life. In this way only can the human race attain a maximum of creative power, the possession of which insures an abundance of all "things" needed.

ALFRED KORZYBSKI. My tribute to the memory of Gantt will be not only the homage of a friend and admirer, but the proof that his philosophy is scientifically true. A rigorous proof is necessary, because the word "service" belongs to that category of words the meaning of which can be completely reversed by the verb, be it "give" or "take." Gantt took the "rendering of service" as an axiom; my observation . . . was that our civilization had quite another axiom: "We preach give, we practice take." The problem which interested me was how to find a way out of this contradiction that would be irrefutable. If one of them is a true and natural law for humans, then the other is not; if our words are true, then our deeds are not true, or if our deeds are true then the words are camouflage. I found the solution by applying mathematically rigorous thinking . . . .

I defined the classes of life by emphasizing their incontestable dimensional characteristics; plants are "Chemistry-binding," animals are "Space binding," humans are "Time-binding" classes of life.

These definitions make it obvious, that:

1 The classes of life have different dimensions, and that as in mathematics the intermixing of dimensions makes a correct solution impossible, so in life the results of such elementary mistakes produce tragic consequences.

2 The old formula on which our civilization is built, Human equals Animal plus or multiplied by Spark of Divinity, is basically and elementarily wrong and is a mathematical nonsense identical with such an absurdity as X square inches equals Y linear inches plus or multiplied by Z cubic inches.

3 This basically wrong formula on which our civilization rests is the cause of all the periodical collapses, wars and revolutions.

4 The old system was built on animal "space-binding" standards, and human "time-binding" impulses were all the time in rebellion.

5 As the theory of gravitation and calculus made engineers and mathematicians masters of inanimate nature, so these tangible and incontestable definitions give them a positive base which will enable them to approach and solve human living problems by establishing the mathematical fact that man is man and not an animal . . . .

8 For the "time-binding class of life" it is obvious, then, that in this dimension "time binding" is the natural law, and, if analyzed and understood, is the highest human aim.

9 Such "natural laws" as "survival of the fittest" for animals, which is the "survival of the fittest in space," result in fight, or the survival of the strongest; whereas such a law, to be a *Natural Law* for humans, must be in the human dimension, which obviously would be the "*survival of the fittest in Time*," resulting in the survival of the best . . . . .

11 All of our ideas have to be revised and the animal "space-binding" standards either rejected as dangerous and destructive, or transposed for "time-binding" standards which will correspond to the natural impulses and laws for humans . . . . .

We are the masters of our own destinies; the responsibility is ours to correct the mistakes of our ancestors and to establish a scientific philosophy, scientifically true law, scientifically true ethics and a scientific sociology, which will form one unified science of man and his function in the universe . . . . .

Gantt's concept of rendering service is scientifically true because it is "time-binding" and therefore true for the human dimension. This is why Gantt's concept has counted for so much, and will survive "*in Time*."

CHARLES W. WOOD wrote that he had had many talks with Mr. Gantt and that he was in agreement with his facts and principles. Mr. Gantt, however, had to use phrases to express himself and one might disagree with a phrase. "Engineering," he said, "is an exact science, but English is not." A phrase used by Mr. Gantt and quoted by Mr. Polakov, to which he would take exception, was: "Reward commensurate with service."

Mr. Wood referred to numerous instances in industry, the school and the home where for the best interests of all the reward does not always go to the efficient, the brilliant or to the strong. For example, to whom should the teacher devote the more attention and, consequently, the greater portion of the public funds—to the bright child, or the dull one? We will all answer, "to the dull one." He needs more, and unless we give him more, things will go hard not only with him, but with the bright ones, too.

But if this principle doesn't work out in any of the other human relations, why do we try to apply it to industry? Doesn't it defeat the very aim which Mr. Gantt had in mind? Can we reach industrial coördination by trying first to establish absolute justice in the distribution of the product? One of his chief reasons for objecting to this phrase, Mr. Wood said, is that capital and labor both perform a service and there are so many loose-thinking efforts to find an equitable system of reward for each.

Isn't it more to the point to suggest rewarding both capital and labor according to their respective needs—which practically abolishes the whole concept of reward as we understand it today?

It is fairly easy, it would seem, to determine what a worker needs. He needs every possible encouragement to express himself to the limit in creative work; and to do this he needs to be freed from economic and social insecurity. Self-preservation and race-preservation are fundamental instincts, which must be attended to if one is to be set free for work worth while. Unless the worker can be certain of eating, and unless he is given a chance to love and mate and bring forth children, the workers will not be in a position to earn very much and our whole industrial organization may be destroyed by the pangs of hunger and sex.

And isn't it easy, also, to discover what capital needs? Capital likewise needs perfect functioning; and if it is allowed to function perfectly it will cause no trouble. Capital, in fact, is an inanimate thing which can be perfectly controlled by engineering; and it should be easier to discover its exact needs than to ascertain what the normal requirements of the living workers are.

There is, Mr. Wood admitted, another factor in our present industrial order which is not so easily disposed of. It is not living labor. It is not inanimate capital. It is a group of living persons known as owners. Some of them perform service. Some of them do not. How are we to reward them? According to the service they personally render, or according to the service their capital performs? And if we pay them for what their capital does, how can we reward the *capital* commensurately? It might be that they would not put this reward back into necessary reinvestments but spend some of the money upon themselves. That would not be "reward commensurate with service." It would not be paying the capitalist for what he does but for what he owns.

Once again, isn't it the scientific solution to consider not what the capitalist does, nor what he owns, but what he needs? He is human and he needs what every human being needs—a chance to function perfectly as a creative human being. If he is capable of rendering service, should he not be equipped to render all he can?

It would seem that Mr. Gantt did answer many of these questions and that his work must lead us to a clearer conception of industry as an agency for the supplying of human needs rather than a scheme for the gratifying of inhuman greed. Instead of seeking to establish rewards commensurate with service, are we not seeking to establish service commensurate with human possibilities? And does not the establishment of such service bring with it all that the human heart can wish?

HUGH ARCHIBALD contributed a discussion in which he drew on his experience in the coal-mining industry to illuminate the principles developed by the author.

Some years ago he was telegraphed for to rescue a mine from being drowned out; the pumps would not work. He found a new boiler plant with water-tube boilers equipped with Dutch ovens, rated at 1500 hp., and about a thousand horsepower of engines altogether in which to use the steam. But there was no insulation on the steam lines and the weather was near zero. There was one line 2000 ft. long which was leaking at every joint; there were no steam traps before the engines; there was no valve between the old boiler plant and the new and steam was condensing in the cold old boilers. Steam, even, was pouring through an old steam-jet blower, making a forced draft up a cold chimney. No wonder that the forcing of the boilers would not run engines and pumps!

Around the mines the industrial structure was working about as well as that steam plant. It needs to be made over and in doing so fundamental laws need to be known. There are leaks to be stopped, insulation to be applied, and steam traps to be installed.

Mr. Polakov has pointed out three elements of "rendering rigorous service," said Mr. Archibald. The first of these is that reward should be commensurate with service rendered. No wage payments which would conform to this rule exist in the coal mines. For instance, mine foremen, who by law are in charge of all inside workings and who may have under them from one hundred to five hundred employees, are paid about a dollar an hour, while the diggers of coal are paid at the rate of two to three dollars an hour. The mine foreman does not suffer from intermittent employment or from "unemployment within employment," as the digger of coal does, so that at the end of the year his earnings are more than the man he employs. The digger of coal, on the other hand, suffers so much unemployment that he has to be rewarded, in part at least, for the time during which no service is rendered.

The second point which Mr. Polakov makes for rendering rigorous service, is the elimination of idleness before securing additional means of production. The intermittency of operation of coal mines has become common knowledge. Almost every one knows that bituminous coal mines operate on an average about 230 days in a year and that not even anthracite mines are in service continuously. There is a great overdevelopment of coal mines and yet more are being opened every day.

A third point for service is the "utilization of available knowledge without awaiting new discoveries." It is safe to say that if engineering work such as H. L. Gantt did in manufacturing were done in and around coal mines, the output of the mines on the days when they were operating would be increased fifty per cent and the cost of mining coal reduced.

Back of all these points is the fundamental law that the purpose of human life is to "bind time," which has been stated by A. Korzybski and to which Mr. Polakov calls attention.

If disregard of fundamental laws produces machinery which will not work, the same disregard will produce social structures which will not work. And if "binding time" is one of the human purposes (and it surely is), then coal mining is violating that law and the coal industry needs redesigning. For as it is now operated, it does not bind time but captures idleness.

We need to know fundamental laws that engineers may design structures which others can operate. Mr. Polakov's paper has contributed to the possibility of a better design.

Locomotives and Locomotive Terminals

Salient Points Brought Out in Discussion of Papers on Increasing the Capacity of Old Locomotives and Modernizing Locomotive Terminals, Presented at Railroad Session of A.S.M.E. 1920 Annual Meeting

TWO important papers presented at the Railroad Session of the Annual Meeting of The American Society of Mechanical Engineers were those entitled Increasing the Capacity of Old Locomotives, by C. B. Smith,[1] and Modernizing Locomotive Terminals, by G. W. Rink.[2] Mr. Smith discussed the problem of providing adequate facilities for keeping old locomotives in service and adapting them to new demands of suburban and local service, emphasizing the need of making provisions for carrying out a program of reconstruction and improvement. The paper by Mr. Rink dealt with the question of providing adequate facilities for the proper maintenance of locomotives at engine terminals, which has an important bearing on the ability of the railroads to handle the increased traffic demands of the country. Abstracts of these papers were published in the January issue of MECHANICAL ENGINEERING. The papers brought forth considerable discussion, the most important points of which are presented in the following extracts.

Increasing the Capacity of Old Locomotives

P. M. HAMMETT.[3] Programs for the application of improvements to locomotives should be carefully studied by each railroad in the light of its own traffic conditions, as no general conclusion is justified. On roads thoroughly constructed and well maintained, new locomotives may be of greater weight and power than can be obtained by the reconstruction of old engines and should be preferred in so far as their greater ability can be continuously utilized. Where conditions do not permit large increase in weight, improved devices should be applied to existing locomotives of such type and age as have further profitable service life of ten or more years.

Roads having main lines or branches where light traffic does not call for maximum performance should be cautious in the application of devices of expensive character to locomotives for such service.

Shop plants on many railroads are inadequate in quantity and capacity to the needs of normal maintenance. In such cases the application of improvements to existing locomotives has been limited rather by shop capacity than by restriction of appropriations. Those improved devices receive most rapid acceptance which impose less burden on railroad shops, either by their nature or by reason of general engineering development and complete manufacture of material by those promoting and offering them to the railroads. Any extensive program for improvement of locomotives should include as an essential part, a study of the period which may profitably be allowed for its execution, and provision of facilities sufficient for its execution within that period.

J. C. HASSETT.[1] An improvement policy was inaugurated on an eastern road in 1910 and 1911 and the first superheater locomotive with piston valves was completed in April 1912. To date 160 locomotives have been so converted, representing an average annual production of 20 locomotives. The fuel saving per locomotive per year varies from $2000 to $3000 at present prices for coal. This has been done without any retarding effect on the output of locomotives regularly scheduled through shops and without any drastic revisions or increase of shop forces.

Experience in applying superheaters to locomotives, applying piston valves, outside valve gears, etc., shows the cost to be about $8500, covering betterment, renewal and overhead charges, as compared to $16,000, the cost of a new locomotive at the time the modernizing was done.

Another phase of this superheating problem is the retention of the old slide-valve cylinders and Stephenson valve gear through the application of a piston-valve type of steam chest. One locomotive was so equipped about six years ago and has been giving continous and satisfactory service since. This application can be made for approximately $1800 less than the amount required to add new cylinders and outside valve gear.

In reference to the weaknesses of the main frames of locomotives built during the past ten years, alluded to by the author, probably no road has been immune. A certain group of 52 locomotives of the 4-6-0 type was built in various lots during 1904, 1906 and 1907. These 52 locomotives sustained 30 per cent of the total frame failures of approximately 1250 locomotives on the road.

In the final analysis of this serious situation it was found that the frame sections were, and had always been, too small, based on the areas of sections established by best engineering principles. In the preparation of the new design, the sections were increased.

Locomotives are receiving heavier frames at an approximate cost of $3500 per locomotive, including additional cross-ties, boiler supports, etc. The performance of these locomotives to date has been very creditable.

The extent to which application of heavier frames of proper size can be made to old locomotives will be in large measure limited by the increased weight which can be placed on axles, bearings, spring riggings, etc., without renewal of these parts.

H. B. OATLEY.[2] The writer desires to bring out the features which have prompted the very extensive superheating programs which have been in vogue on many of the railroads for a considerable period. The table accompanying this discussion gives

COMPARISON OF SATURATED AND SUPERHEATED STEAM LOCOMOTIVES OF VARIOUS TYPES

	4-4-0		4-4-2		2-6-0		0-6-0		2-8-0	
Cylinders, in.	20 × 24		22 × 26		19 × 26		20 × 26		21 × 30	
Wheel diameter (drivers) in.	69		80		63		51		63	
Boiler pressure, lb. gage	190		205		200		180		210	
Tractive power (maximum) lb.	22470		27470		25300		31100		37500	
	Sat.	S.H.	Sat.	S.H.	Sat.	S.H.	Sat.	S.H.	Sat.	S.H.
Weight on drivers, lb.	94000	96000	124100	126000	125500	128000	144600	147600	172500	176500
Factor of adhesion	4.18	4.27	4.51	4.59	4.96	5.06	4.65	4.74	4.6	4.7
Heating surface, tubes, sq. ft.	1957	1035	2474	1335	1732	948	1750	987	3194	1737
Heating surfaces, flues, sq. ft.		402		506		392		412		650
Heating surfaces, firebox and water tubes, sq. ft.	232	232	166	166	158	158	156	156	189	189
Total heating surface, sq. ft.	2189	1669	2640	2007	1890	1498	1906	1555	3383	2576
Superheating surface, sq. ft.		314		435		296		306		530
Combined total heating surface,[1] sq. ft.	2189	1983	2640	2442	1890	1794	1906	1861	3383	3106
Total water evaporated, lb.	31530	25930	32228	25728	26720	22120	28430	23610	40960	32510
Steam per hp-hr., lb.	27	19.5	27	19.5	27	19.5	27	19.5	27	19.5
Boiler horsepower	1165	1330	1196	1320	989	1135	1052	1210	1515	1667
Boiler hp. increase, per cent		14		10.2		13		15		10
Maximum cylinder horsepower[2]	1265	1369	1655	1786	1202	1300	1199	1297	1543	1667
Per cent boiler hp. of cylinder hp.	92.3	97.5	72.3	74	82.9	87.4	87.7	93.2	98.1	100

[1] American Locomotive Co.'s method used but figures are those used by Locomotive Superheater Co.
[2] American Locomotive Co.'s figures used.

[1] Mechanical Engineer, Boston and Maine Railroad.
[2] Assistant Superintendent Motive Power, Central R. R. of New Jersey. Mem.Am.Soc.M.E.
[3] Supt. of Motive Power, Maine Central Railroad, Portland, Me. Mem. Am.Soc.M.E.

[1] Mechanical Engineer, N.Y. N.H.& H.R.R. Co.
[2] Chief Engineer, Locomotive Superheater Company, New York. Mem. Am.Soc.M.E.

some comparisons between saturated and superheated locomotives of some of the types mentioned by the author.

By the addition of a high-degree superheater it has been demonstrated that the steam consumption per horsepower-hour is reduced about 28 per cent. The figures commonly accepted as representing good practice are 27 lb. for saturated steam and 19.5 lb. for superheated steam. It will be noted that in the case of the 0-6-0 type boiler the horsepower has been increased 15 per cent; for the 4-4-0 type 14 per cent; for the 2-6-0 type 13 per cent, for the 2-8-0 type 10 per cent, and for the 4-4-2 type 10.2 per cent.

The maximum cylinder horsepower, using the American Locomotive Co.'s figures, has, by the addition of a superheater, been increased about 8 per cent.

When considering existing locomotives the increase in the maximum tractive power requires consideration of (1) the factor of adhesion, and (2) the strength of the running gear, which has to withstand the thrust of the piston.

As in all other problems, the cost of making improvements must be balanced against the advantages which can be realized.

W. O. Moody.[1] Where a program involves the modernizing of a large number of locomotives, it necessarily follows that the work must extend over a period of years, which time may be extended due to market conditions, as an inflated price situation may make it advisable temporarily to suspend the work.

Water and fuel conditions in different localities may be governing factors in determining the policy of reconstruction, so that what would answer all requirements to a class of power in one section would not guarantee equally favorable results elsewhere.

To do this work under a well-studied program on any extensive scale will call for increased shop facilities either in space or old tools replaced by modern, so that the old shop is also modernized to be in harmony with its new output.

By purchasing many of these devices, on the open market, machined and assembled, the back shop is relieved of a fair percentage of the burden of manufacture.

Outside valve gears can be purchased and applied without a very great increase in shop work over a link motion, which may require renewal of a large number of parts.

It would be well to send to each of the larger roads a questionnaire prepared with a view to bringing out their program, with list of engines modernized to date, and those remaining, to furnish a general idea of the extent to which this work is being done.

We also have another factor which determines the reconstruction program. A road may have a satisfactory class of saturated engines, which on later orders have been equipped with superheaters and larger cylinders, so that it is a wise policy to have the superheated type serve as models when reconstructing the saturated ones and thus reduce class, and likewise the storehouse stock and patterns.

Some prominence is being given to one feature not mentioned among the author's eighteen items of improvement: namely, the booster which apparently has a wide field of application to either freight or passenger power, depending somewhat on local conditions for the most favorable results.

E. A. Averill[2] gave as an example of what can be accomplished on even some of the more modern locomotives built within the last six or eight years, results recently obtained from road tests on locomotives equipped with feedwater heaters. Tests were made on three different railroads and showed an average of $237 saved in fuel cost per month per locomotive.

Feedwater heaters which will raise the temperature of the water from 40 or 50 deg. to from 230 to 250 deg. have been in successful railroad service for over three years. These heaters filter all the water formed from the condensed exhaust steam and return it, free from oil, to the tender. This adds about 14 per cent to the capacity of the tender and greatly extends the distance that can be made between stops for water.

On most locomotives an increased boiler capacity can be fully used in regular service, and furthermore, since any boiler is most economical and most efficient at its lower rates of working, an appliance which makes the boiler larger always shows returns.

J. T. Anthony.[1] Of 65,000 locomotives in service on American railroads, only 35,000 are equipped with superheaters, 43,000 with arches, 37,000 with automatic fire doors, 15,000 with power reverse gears, 2000 with automatic driving-box wedges, and only 30 with feedwater heaters, to mention only a few of the items listed by the author.

The brick arch can be installed in the roundhouse in less than 24 hours, and to use a conservative figure, is good for an average reduction in fuel consumption of 10 per cent, or an increase in boiler capacity of 11 per cent.

There is probably a wide diversity of opinion as to the relative merits of the 18 items given by the author as desirable improvements and there are several other items that could be added to a program for the rehabilitating of old locomotives, such as the booster, radial buffer, automatic grate shaker, and thermic siphon. Perhaps the author had the latter device in mind when he mentioned improved circulation and increased firebox heating surface.

There are only three methods of increasing the heating surface of an existing firebox, i.e., by the installation of combustion chamber, the installation of arch tubes, or thermic siphons. At the present time there are only 6000 locomotives equipped with combustion chambers, and something over 100 equipped with thermic siphons, this device being of rather recent origin.

Frank McNamee[2] said that he concurred with the first two statements of the author's paper, but that the second did not go far enough. In other words, he said, it was not enough to modernize existing locomotive equipment by adding new locomotives to it or by rebuilding old types. The new locomotives and the modern devices with which the rebuilt ones were equipped must be maintained. Superheaters, brick arches, mechanical stokers, feedwater heaters and other modern devices mentioned by the author must be properly maintained to be effective. The modernizing of locomotive terminals and the provision of an organization to maintain the improved devices is a third method.

G. W. Rink said that the conditions of the C.R.R. of N.J. were similar to those mentioned by the author, there being a heavy suburban traffic which required the services of all the locomotives owned by the road. A constructive program was under way for modernizing the locomotives by the application of various devices. The program consisted, he said, in the application of superheaters and cylinders, thus increasing the tractive power of suburban locomotives so that they could haul 11 or 12 steel coaches rather than nine as previously. A number of tender frames had been changed, enlarging the capacity from 5000 to 7500 gal. Outside valve gears were also being applied to heavy consolidation locomotives equipped with Stephenson motion.

Modernizing Locomotive Terminals

William Elmer[3] presented a discussion of this paper to show that much could be accomplished by closer supervision of existing terminals through a system of daily reports. He said the greatest effort should be made to get the maximum possible mileage and service out of the engines and that the first thing to do is to impress everybody with the value of an engine-hour. In support of this he noted the following instance:

On one of the divisions of the Pennsylvania Railroad the freight earnings were $4,000,000 in a recent month. The average number of serviceable freight locomotives was 78 and they were on the road 52 per cent of the time. As there were 720 hr. in the month this is the equivalent of an average of 41 engines working constantly, or 29,500 locomotive-hours. As they earned $4,000,000 each engine-hour was worth $137. Now if every man connected with the motive-power department could be made to realize that an engine is worth from $100 to $200 an hour, he believed we should see a great improvement in the pace of everybody around a locomotive terminal, from the hostler to the foreman.

Mr. Elmer described fully how by means of complete daily statistics of the engines under and awaiting repairs at the various

[1] Mechanical Engineer, Illinois Central R. R. Co., Chicago, Ill. Mem. Am.Soc.M.E.

[2] Vice-President, Locomotive Feed Water Heater Co., New York. Mem. Am.Soc.M.E.

[1] Vice-President, American Arch Company. Mem.Am.Soc.M.E.

[2] Assistant Director, U. S. Railroad Administration.

[3] Division Superintendent, Pennsylvania Railroad, Altoona, Pa. Mem. Am.Soc.M.E.

shops and enginehouses and those which were on the road as recorded on the train sheets or loaned to or borrowed from other divisions, the average miles per active freight locomotive per day had been increased in the last eight months from 139.2 to 161.8.

E. M. HAAS.[1] The real measure of a terminal's adequacy will be found in its ability to function under the most trying demands of traffic and weather. Elasticity of movement over the track layout and reserve capacity in the various facilities that may be called upon in an emergency are fundamental. In arranging the tracks and various terminal facilities, it must be borne in mind that if the best operating results are to be obtained, the terminal should be planned to restore power to service in the shortest possible time.

Serious consideration is now being given by the motive-power departments of several roads to the use of more small back shops and fewer general-system shops. This seems to work itself out best, unless the number of locomotives turned is quite small, by having these back shops located at every other terminal; that is, the intermediate terminal simply serves for turn-back purposes and handling light running repairs. It has been found that the efficiency obtained from large aggregations of labor and tools is lower than from smaller units, where more intense supervision is possible. Furthermore, smaller units simplify the labor problem and tend to maintain a continuity of repair service in case of local labor difficulties. Finally, a larger number of shops reduce materially the dead mileage of locomotives between the terminal where they are released and the shops where they are repaired.

Serious mistakes have been made recently in connection with some recently built terminals in selecting their location without giving proper consideration to the labor side of the question. It is more economical to pay more for terminal property if this is necessary in order to insure a constant supply of labor.

Drainage is another factor to consider in locating a terminal, bearing in mind that the turntable pit, drop pits, and pits under the track hopper at the coaling station are the controlling points.

No terminal track layout is complete without separate tracks for inbound and outbound movements and at least four tracks leading to and from the turntable. It should also be so arranged that locomotives may receive coal, water and sand inbound or outbound.

The test of terminal facilities is their ability to function in zero weather. While a terminal may function readily under normal traffic and weather conditions, it cannot be considered adequate if it fails under unusual conditions. At a terminal handling 170 locomotives in 24 hours the writer recently found 15 locomotives waiting at the ashpits to have their fires cleaned. Two improvements were necessary to relieve this situation: more tracks over the ashpit and greater ash storage capacity, as the pits were of the shallow-water type located between the rails. It will be seen that if this delay occurred every day and averaged 30 min. per locomotive, the capitalized earning power of the locomotives would more than finance the entire cost of a terminal of this kind.

Roundhouse and Shop. The author makes only passing reference to the type of roundhouse to be used. Generally speaking, the writer believes that all roundhouses should be of fireproof construction and that terminals handling 75 locomotives and up should be provided with bridge cranes, or at least jib cranes at each stall. Recent experience seems to show that it is a mistake to provide only a bridge crane in a roundhouse, as the demand for service is more than one crane can supply. Therefore it is probably better to provide jibs at each stall in addition to a bridge crane and use the jibs for the lighter work.

Light-Repair Shed. A development which seems to have real possibilities has been put in practice on several roads and takes the form of a light-repair shed. Locomotives requiring the minimum of attention from the repair force are put through this shed, which may be located near the roundhouse, where it can be under the supervision of an assistant to the roundhouse foreman, and convenient to the storehouse and machine shop.

Coaling Stations and Sand Storage. The writer believes that the question of coal-storage capacity at terminals has not received sufficient attention. Coal in the bins sufficient for a 24- or 48-hr. period is not enough in an emergency. In the writer's opinion the emergency coal storage should be sufficient to meet at least 30 days' requirements.

Storage space for wet sand should be sufficient for the entire requirements of the terminal for the winter months. Preferably it should be so arranged that the sand can be unloaded by a locomotive crane, or the sand may be dumped into the bins from the cars without unloading by hand. The bin construction should be such that sand can be protected from the rain and snow.

Ash Handling. In districts where the winters are severe, the location of the ashpits with relation to the enginehouse is important. The distance should not exceed 1000 ft. and should preferably be about 700 ft. from the house. The purpose of this is to prevent the detrimental action of cold air on the flues and permit the uninterrupted movement of the engine to the house.

In considering the type of ashpits to be used, time should be the controlling factor. It can be shown, for instance, that the depressed-type pit is cheaper to operate than a water-type pit, particularly when the fixed charges of both are considered; but the reliability of the water type under all weather and labor conditions is what has convinced many roads of its superiority over other types.

Turntables. The longer turntables result in a more economical use of floor space in the enginehouse. In other words, about 54 stalls can be obtained with a 100-ft. table and 72 stalls with a 125-ft. table. Larger tables permit more track approaches to the table without frogs and result in a smaller angle of spread in the sides of the stalls. Some engineers have figured that the saving in floor space in the enginehouse resulting from the use of a 125-ft. table over that of a 100-ft. table would pay for the increased cost of the longer table. A new development in turntable construction which permits the handling of large Mallets on short tables is the 3-point bearing table. This is now in use on the Pennsylvania Lines and is being considered by a number of other roads.

Inspection Pits. General opinion seems to agree with the author that the inspection pits are essential to modern terminal operation and that the inspectors should be protected from the weather. An office should be provided at this point where the crews, as well as inspectors, can make out their reports. This office should be connected to the roundhouse by a pneumatic-tube system for the transmission of reports. As a matter of interest, it has been found that more satisfactory results can be obtained from these tubes if they are installed overhead rather than underground.

Recently several have suggested that certain light repairs be undertaken at the inspection pit. Inasmuch as the time required at the ashpit largely controls the movement of power to the roundhouse, in many instances it would be possible to undertake light repairs at the inspection pit. This would consume most of the time which in many terminals is wasted by locomotives waiting for their turn at the ashpits.

Wash Pits. Another development which has been adopted by several roads is the installation of a wash pit for cleaning locomotives by oil, water and air spray. This method, it is said gives better results than attempting to do the work in the roundhouse and is much cheaper.

Heating and Ventilation. Recently the writer heard a discussion of this subject as it relates to enginehouses and concluded that in some instances, at least, the motive-power departments were opposed to the hot-blast heating system.

The satisfactory results obtained by many roads recommend this system above any other for roundhouses, because it does assist in ventilation, which is essential for good results in the roundhouse. The blast may be controlled by dampers at the outlets and it has the advantage of being serviceable all the year round. In the summer months outside air may be forced through the system for ventilating purposes only.

The author refers to the smoke-exhaust system as being used for the purpose of meeting the objection to smoke on the part of the public. There is real economy in the smoke-exhaust system, in that it saves the live steam used in the blower lines and at the same time makes possible a reduction in the amount of fuel required to get good heat in the house during the winter months.

Oil House. The author specifically recommends that the oil

[1] The H. K. Ferguson Company, Cleveland, Ohio.

house be in a separate building. In a recent discussion of this subject by railroad-building engineers, it was agreed that for small terminals better results could be obtained by making the oil house a part of the storehouse so that it could be handled by the storekeeper.

Storehouse. The storehouse is a terminal facility that usually does not receive the attention that it should. Generally, very few labor-saving devices are provided for unloading or transporting supplies and there are instances where very substantial savings could be made if these matters were seriously considered.

T. N. GILMORE[1] In considering the extent of the shop facilities to be provided, it seems necessary to classify engine terminals into three classes, of equal importance.

The first we may designate as the divisional terminal, more remotely located from the main shop and where in connection with the roundhouse, which would be supplied with all the usual facilities, there would be a small erecting shop with its machine shop.

Second are main divisional roundhouses which would be responsible for maintenance of running repairs on all locomotives running out of them. Such a terminal would be supported more or less directly by a main shop, located adjacent thereto.

Third are the intermediate or engine-turning roundhouses where all locomotives entering the terminal run out of a main roundhouse at the opposite end of their runs, where running repairs are maintained.

In the first class, where a considerable number of engines are given light classified repairs between general overhaulings in the main shop, it seems desirable in point of time and cost to provide a separate shop equipped with unwheeling device and crane for handling the heavy parts of the locomotives, with a very complete outfit of machine tools, including those required for renewing and turning tires of drivers, truck and trailer wheels, heavy driving-box work and quite thorough repairs to the locomotive, with boiler-shop facilities for renewing flues, and a blacksmith shop.

A shop of this kind should be fully provided with standard trams, gages and templets in order properly to maintain established standards, and should be provided with a sufficient line of standard reamers and hand tools. The shop management should also be furnished detailed drawings of the locomotives in service.

The engine terminal supported more or less indirectly by a nearby main shop would require its own machine shop with machine tools sufficient to take care of the general heavy running repairs, depending upon the main shop or the storeroom for manufactured material such as crankpins, rods, crossheads, knuckle-joint pins, etc.

Of equal importance, however, is the full complement of mechanics' hand tools in sufficient number to avoid one workman's having to wait on another for a tool. In fact, the tool equipment should comprise all modern labor-saving appliances that will contribute to economy and speed of performance.

At the intermediate terminals where provision is made elsewhere for other than minor running repairs, the facilities, aside from the roundhouse, would consist of oil house, sub-store, suitable coal and cinder plants and water supply, including a sufficient dependable supply of steam for heating and other requirements, and also, where boilers are to be washed out, a hot-water boiler-washing system.

As before mentioned, the engines running into this class of terminal, at the opposite end of their runs, go into a roundhouse fully equipped to take care of running repairs.

It is relatively a simple matter on a comparatively short, compactly situated railroad system to decide on the location of each of these types of terminals. It becomes a very different matter, however, to locate and classify these terminals on the larger systems extending from New York to Chicago, St. Louis and Cincinnati and from Chicago to the Pacific Coast and St. Paul to the Coast and on systems where there are many branch lines.

In support of this general classification of engine terminals, the writer holds that every locomotive in service should have a home and an organization responsible for obtaining the proper average mileage between heavy general repairs.

[1] Vice-President, Dwight P. Robinson Company, New York. Mem.Am. Soc.M.E.

In the recent discussion on electric and steam locomotives the point was brought out that the electric locomotive could not be successfully operated under certain overload conditions, where the steam locomotive, if overloaded, would manage to get along somehow in a more or less indifferent manner.

It is a lamentable fact that the steam locomotive too often is continued in service in such condition that it may be said to be getting along somehow, resulting in poor transportation results and bad fuel economy.

The engine terminals of a railroad cannot be expected to maintain heavy power in good condition without the support of modern general repair shops to regularly and periodically put the engines into 100 per cent condition.

No locomotive terminal can be made modern without giving it an up-to-date organization. There should be no division of authority.

The proper spirit of cooperation should be built up and maintained between the different departments to enable this to be successfully carried out without friction and to the benefit of all departments.

L. G. PLANT.[1] The locomotive terminal is a unique mechanical facility in that it admits of very little standardization. There are, however, certain well-defined principles relating to terminal layout that should govern in modernizing locomotive terminals. It is safe to say that where trackage is ample, a well-defined routine for the movement of every locomotive can be strictly adhered to.

With respect to coal chutes and sanding facilities, it should be borne in mind that the particular type of construction and the particular mode of operation are of no significance unless they insure both capacity and reliability in operation. The cost of delivering coal to locomotives is an important item and the coal chute should also be designed so as to minimize this cost.

The arrangement of fire-cleaning facilities and ash-handling apparatus is easily the most vital feature exterior to the roundhouse. The importance of these facilities lies in the fact that whereas the time consumed in taking coal and sand can hardly be in excess of ten minutes, the time over the ashpit may easily take one or two hours unless these facilities are reasonably adequate. The superiority of the water pit at any point where a considerable number of locomotives are to be handled can hardly be questioned, but this should be so designed that the locomotive ashpan is accessible to fire cleaners working on either side of the locomotive. Moreover a short transverse pit serving several pits is always preferable to a long longitudinal pit serving but one or two tracks. The principles which have been referred to as governing the track layout at the terminal apply with equal force to the arrangement of the ashpit.

The author is to be commended for his emphasis on the advantages of suitable inspection pits over which the locomotives pass before having their fires drawn.

Those sections of the paper dealing with heating, ventilation and lighting elaborate upon details that are very essential to the successful operation of any locomotive terminal. The author, however, has questioned the advisability of using the down-draft system of ventilation without putting sufficient emphasis upon the fact that this system as applied to roundhouses on the Pennsylvania Lines West has enabled the use of 75-ft. overhead cranes throughout the entire circumference of the roundhouse, which is in itself a most important labor- and time-saving facility.

The installation and maintenance of the down-draft system referred to is doubtless an expensive item, but it should be borne in mind that by this means locomotives can be fired without the use of the steam blower and that the elimination of noise as well as smoke and steam from the interior of the roundhouse is a most desirable feature.

The mention of cranes suggests the question as to whether one of the most important elements in the modernized terminal has not been overlooked in the presentation of this paper. That is the use of cranes, electric tractors and other means employed for removing and replacing heavy parts of the locomotive and for conveying materials about the terminal.

(*Continued on page 272*)

[1] Associate Editor, *Railway Age*, New York.

SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

The Properties of Steam

At the end of last year there was published in London a work entitled, The Properties of Steam and Thermodynamic Theory of Turbines, by Prof. H. L. Callendar, which has attracted a great amount of attention. *Engineering* says that the author's Royal Society papers embodied in this treatise "undoubtedly constitute the most illuminating and reliable work on the properties of steam accomplished by any engineer or physicist since the pioneering labors of Regnault, Rankine and Kelvin." The following abstract is made from articles in the issues of that journal for Jan. 21 and 28, 1921.

In the complete equation of state for gases and vapors

$$V - b = \frac{RT}{P} - c. \qquad [2]$$

there is a term c known as the co-aggregation volume. It represents the diminution of volume due to the pairing of the molecules.

The problem of determining how this co-aggregation volume c varies with the temperature, pressure and volume of a gas has occupied the attention of physicists for years. The Van der Waals equation of state leads to a very complicated expression for c and moreover expresses the relation between the temperature, pressure and volume of a gas qualitatively only. It would hardly be going too far to assert that of late years the Van der Waals equation has been a hindrance rather than a help. It has tempted investigators to endeavor to include in a single formula all the properties of a body whether in the liquid or the gaseous state, right up to the critical point. This feat has not been accomplished for any single body, and the attempt to do so in the case of steam where reliable data near the critical point were wholly lacking has been ill advised at the best. This has been emphasized recently by a new and accurate determination of the critical temperature, which turns out to be some 9 deg. cent. higher than the value adopted by the German and American computers who have published elaborate tables on the properties of steam.

Some 20 or 25 years ago the properties of steam were considered as adequately established by the Regnault formula:

$$H = 1091.7 + 0.305\,(t - 32). \qquad [a]$$

Based on this formula Professor Peabody devised his throttling calorimeter for estimating the quality of steam supplied to engines under test, but when it was used in certain tests it was found that the wetness of the steam supplied by the boilers as calculated from Regnault's formula persisted in coming out negative. In other words, the throttling calorimeter declared the steam supplied to be superheated when it was not. This led to an exhaustive investigation at McGill University by Professor Callendar, which showed conclusively that the Regnault formula was wrong.

German investigators substituted for it empirical formulas which neglected, however, to take into consideration the fact that there is a close connection between the thermal properties of steam and its specific volume. Because of this the elaborate tables compiled in America on the basis of German experiments and formulas are claimed to fail to satisfy the test which consists in that the work done in a given cycle should be the same whether it be measured on the temperature-entropy chart or on the indicator diagram.

Callendar attacked the problem in a different manner. He devised new and extremely accurate methods of determining total and specific heats and of determining with precision the law for the adiabatic expansion of steam. He also devised formulas to represent the properties of steam and laid down the principle that these formulas must be consistent with each other. Any formula for the total heat of steam must be consistent with Equation [2] *ante*, and with the experimentally demonstrated fact than the adiabatic expansion of steam is represented by the equation

$$PT^{-\frac{13}{3}} = \text{constant}$$

The adiabatic expansion of an ideal gas satisfying the equation $P(V - b) = RT$ can also be represented by a formula of this kind. The more usual formula in this case is $P(V - b)^{\gamma} = \text{constant}$, but on substituting for $V - \gamma$, this takes the form

$$PT^{\frac{\gamma}{1-\gamma}} = \text{constant}.$$

Any adiabatic expansion is effected at the expense of E, the internal energy of the body. In the case of the ideal gas it is well known that this internal energy (expressed in ft-lb.) can be represented by the formula

$$E = \frac{1}{\gamma - 1} P(V - b)$$

where γ is the index in the usual formula for the adiabatic expansion of such a gas. The above expression represents, in fact, the work which can be done by the gas when expanded adiabatically down to zero pressure. Now so far as the internal energy of steam is due to the molecular velocities and spins, it must be capable of being represented in the same way. Hence in the case of steam we may write—

$$E = \frac{1}{\gamma - 1} P(V - b) + B$$
$$= \frac{10}{3} P(V - b) + B$$

The work done in an adiabatic expansion is equal to the change in the internal energy, and if B be constant this change of internal energy will be exactly the same as it would be in the case of an ideal gas having the same value of γ as steam has, and it is perhaps fairly obvious that the law for adiabatic expansion will then be expressed by the same formula.

Whether B is or is not constant is a matter for experiment. Since we cannot conveniently measure directly the internal energy of steam, these experiments are best made by determining the total heat H which is defined nowadays by the relation—

$$H = E + PV$$

This differs from Regnault's definition in that Regnault took no account of the energy required to drive his feed pump. In this equation all quantities of energy must, of course, be expressed in ft-lb units.

The difficulty of determining accurately the total heat of steam has been solved by Callendar, who did it by comparing the total heat of high-pressure steam with that of superheated steam at atmospheric pressure, which latter can be determined with considerable precision. In making an experiment the high-pressure steam is withdrawn down to atmospheric pressure through the equivalent of a porous plug and its temperature noted after passing this plug. In an operation of this kind the steam retains after its expansion its original total heat, and as the total heat of superheated steam at atmospheric pressure is known from the preliminary experiments made, a very simple method of finding the total steam at higher pressures is thus provided.

It is of interest to note that the results obtained by Callendar agree quite well with the unknown unextrapolated figures published by the German investigators and with direct determinations of specific heats made by Prof. Carl Thomas.

These observations show that within the experimental range B may be taken as constant. Callendar thus obtained the following formula for the total heat of superheated dry saturated or super-

saturated steam expressed in British thermal units (in this formula the pressures are taken in pounds per square inch):

$$H = \frac{13}{3}\frac{p}{777.8} \times (V - 0.01602) + \frac{0.01602}{777.8}p + 835.2 \ldots [b]$$

With this expression for the total heat the observed law of the adiabatic expansion of steam is satisfied, but it is also necessary that the equation of state be satisfied, namely,

$$V - b = \frac{RT}{P} - c \ldots [c]$$

This gives a clue as to the character of the variation of the co-aggregation volume with the pressure and the temperature, which is determined mathematically. The expression finally derived for [c] is quite a complicated one and involves a number of coefficients of which Callendar has shown that they are so small as to be negligible at ordinary pressures, though they may become important as the critical point is approached.

In this connection the physical meaning of the critical point is discussed. In general, if any liquid is exposed to a gas, some of the gas is dissolved. When the gas in question is its own vapor the rule still holds and Callendar has shown that the observed increase in the specific heat of water as the temperature rises is almost wholly accounted for by the latent heat of the dissolved steam. The amount of this dissolved steam present increases as the pressure of evaporation rises and hence the latent heat required to produce this dissolved steam increases with the temperature of the water and this occasions an apparent increase in the specific heat of the liquid.

For pressures not near the critical point but within the practical range the volume is given accurately by the expression (temperatures in centigrade degrees and pressures in pounds per square inch):

$$V - 0.01602 = 1.07061\frac{T}{p} - 0.4213\left(\frac{373.1}{T}\right)^{\frac{10}{3}}$$

The equation for the total heat of steam and that expressing the relation between the volume, temperature and pressure which are given above are fundamental and from them all other equations required may be derived. As an example, the original article shows how the expression for the entropy is derived and how and why this expression must apply also to dry saturated steam. The latter, however, is equal to $\phi_w + \frac{L}{T}$, where ϕ_w is the entropy of water at the absolute temperature T, and L is the latent heat of steam at the same temperature. If we equate these two expressions and solve the resulting equation for p, this (if Callendar's formulas are reliable) should be equal to the saturation pressure as determined by Regnault and others. The test is a very crucial one and it turns out that the agreement is extraordinarily close, the computed figures differing less from the results obtained by different experimenters than these do from each other.

Indeed, Callendar has shown that his equation for the saturation pressure can be put into a form which is with the exception of a corrective term depending on the co-aggregation volume is identical with the theoretical expression for an ideal liquid and vapor as deduced by Rankine in 1866.

Another test which any set of reliable steam tables should successfully pass is that the specific heat must be the same whether deduced from the total heat or from the pressure, volume and temperature. Since the specific heat at constant pressure can be expressed mathematically as—

$$\frac{dH}{dT}\Big]_P$$

but is also equal to the expression

$$\frac{1}{J} \times T \times \frac{dV}{dT}\Big]_P \frac{dP}{dT}\Big]_\phi$$

where the suffix P denotes that the volume is changed at constant pressure, and the suffix ϕ that the pressure is changed at constant entropy, that is, say, by adiabatic expansion.

It is claimed that it will be found on trial that all the tables based on the German formulas for the total heat and specific volume of steam fail to satisfy this test, the discrepancy being as much as 20 per cent, and that the only tables which do so are those based on Callendar's work.

Among other things, Professor Callendar in his treatise gives an analysis of Professor Stodola's experiments on the losses in a convergent-divergent nozzle. Stodola himself was not satisfied with the conclusions to which his own analysis apparently led, as this indicated a frictional loss of some 20 per cent, and the losses were distributed in a somewhat anomalous way. Callendar shows that when the supersaturation of the steam is taken into account the frictional loss comes out at from 6 to 10 per cent, which is a much more reasonable figure.

As regards the state of supersaturation in steam, Professor Callendar takes the view that after the Wilson line is crossed the steam temperature during the remainder of the expansion is that corresponding to the Wilson line, while the water temperature is the saturation temperature corresponding to the pressure. From this it follows that in the first approximation the Wilson line can be regarded as replacing the saturation line on the old theory and that formulas deduced on the hypothesis that the steam expands in thermal equilibrium require only a small adjustment to suit the actual conditions.

The trouble with expressing the phenomena attending the expansion of wet steam in thermal equilibrium is due to the great complication of the exact expression for their reheat factor. Professor Callendar finds, however, that it can be obtained with remarkable accuracy from the semi-empirical formula—

$$\frac{\epsilon}{\eta} = 1 + (1 - \epsilon)x$$

where ϵ denotes the efficiency ratio and η the hydraulic efficiency of the turbine, while x is equal to u, the adiabatic heat drop divided by $2(H_\phi - st)$. Here H_ϕ denotes the total heat at exhaust had the expansion been adiabatic, and $st = t - \frac{t}{300}$, where t is the final temperature centigrade. This formula will greatly add to the facility with which turbine tests can be analyzed, and in view of what has been said above should be capable of modification to meet the case of the expansion of wet supersaturated steam. In view of the fact that the total heat of steam in ft-lb. units is given by the relation—

$$H = \frac{\gamma}{\gamma - 1} \times P(V - b) + Pb + B$$

on neglecting b a formula of the type $P(V - b)^\lambda$ = constant, can be transformed into an equation of the type—

$$H - B = kP^m = \text{constant}$$

For superheated or supersaturated steam expanding with a hydraulic efficiency η, the value of m is $\frac{3\eta}{13}$. Callendar finds that an equation of the same form can be made to represent with great accuracy the expansion of wet steam in thermal equilibrium. In that case the value of m is fixed by the condition that

$$\frac{P_0V_0}{P_1V_1} = \frac{P_0^m}{P_1^m}$$

while k and B are determined by the initial and final values of H and P. This equation is very simple to apply and should also be suitable for the expansion of wet supersaturated steam. We are thus furnished with a new method of turbine analysis. The difficulties under which we have hitherto labored are well illustrated by the circumstance that after a most careful and extensive series of tests on a small reaction turbine made a few years ago in his laboratory by one of our leading authorities, the task of interpreting the records obtained had in the end to be abandoned in despair. (*Engineering*, vol. 111, nos. 2873 and 2874, Jan. 21 and 28, 1921, pp. 63–65 and 93–94, *tex.*)

[The statement made in the foregoing abstract to the effect that American steam tables based on German formulas are in error, in some respects as much as 20 per cent, is of course one for which the author of the articles is responsible. Similar but less specific comment appeared in an article on a new theory of the steam turbine, by H. M. Martin, in *Engineering*, July 5, 1918, which was quoted in the Survey Section of September 1918, p. 785.]

Short Abstracts of the Month

AERONAUTICS

THE LEITNER-WATTS ALL-METAL PROPELLER. It is stated that all but one of the problems of the metal propeller have been solved in this device, and that one is weight. In their present form these propellers are very much heavier than corresponding wooden screws.

The blades are each made up in the form of a shell of sheet steel and the necessary taper in thickness is obtained by using laminated construction, there being three laminations—one at the top, the second about halfway between the tip and the boss, and the third at the root. The laminations are at present riveted together, but later on it is intended to employ electric spot welding.

The two halves of each blade are attached to one another at the edges only by welding, but in order to stiffen the shell thus formed small struts are placed between the two faces at intervals.

The method of inserting these struts is shown in Fig. 1. The struts are shouldered at both ends and the hole in one face of the

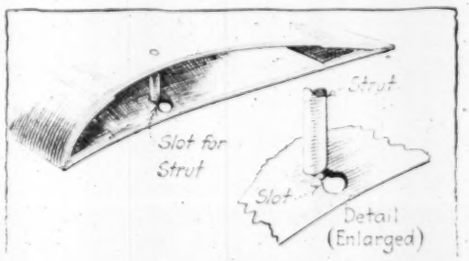


FIG. 1 METHOD OF INSERTING SMALL STRUTS BETWEEN FRONT AND REAR FACES OF THE LEITNER-WATTS ALL-METAL PROPELLER

blade is made just the right size to take the thin portion of the strut. In the other face of the blade is cut a hole large enough to accommodate the thick portion of the strut. From this hole runs a slot of a width corresponding to the shouldered portion of the strut. To place in position, the strut is inserted in the large hole, its other end being pushed into the small hole on the opposite face, and the shouldered portion is slid into the slot. The strut is then secured in position by soldering washers over the two strut ends.

The root of the blade is constructed in a very substantial manner. Balance of the blades is secured by using small balance weights carried on short lengths of tube secured to the inner end of the central plug in the blade root. These propellers have an adjustable but not a variable pitch, which means that the pitch angle of the blades can be altered over a wide range (10 deg. each way), thus making the propeller suitable for a number of different conditions by setting the pitch according to requirements. (*Aerial Age Weekly*, vol. 12, no. 22, Feb. 7, 1921, pp. 559–560, 3 figs., *d*)

AIR MACHINERY

RELATION OF AIR PRESSURE TO DRILLING SPEEDS OF HAMMER DRILLS, H. W. Seamon. Data obtained in 1500 tests made by the United Verde Copper Co. to determine the most economical air pressure for the operation of hammer drills under varying conditions of use, and to investigate the variation in drilling speed at different air pressures.

Twelve models of drills, all of the wet type, were used at gage pressures ranging from 40 to 130 lb. per sq. in. Seven drills were of the heavy mounted class, three of the jackhammer type and two stopers. The drilling was done in massive sulphide ore of uniform hardness, the same face being used for all tests. Horizontal holes were drilled with the mounted machines and vertical holes with the stopers.

Shop measurements of the power of the drills were made on a Paynter rock-drill tester, which records the number of blows per minute and the strength of the blow, and the values thus obtained were assumed to be the same in the testing ground under the same gage pressures.

Tables are given in the original paper showing for each one of the drills tested the number of blows per minute, the strength of the blow, the horsepower developed, the drilling speed, the air consumption, the efficiency and the distance drilled, under air pressures varying from 40 to 130 lb. per sq. in.

From the figures obtained an empirical formula is derived for the "factor of desirability" of a certain type of drill in terms of its cost of operation and maintenance.

Analysis of the results obtained leads to the following general conclusions:

There is little or no increase in mechanical efficiency of the drills above 90 lb. pressure.

The distance drilled per air indicated horsepower is greatest for the jackhammer type at 90 lb., and increases at a slow rate for the other machines at the higher pressures.

The average thermal efficiency is greatest at about 95 lb.

The factor of desirability, while increasing as the pressure, shows a comparatively slow rate of increase for pressures above 100 lb.

The average drill is made to be used at a pressure of 80 lb., or less; using pressures much exceeding this will invalidate the present replacement agreements with the manufacturers, thereby increasing the upkeep cost.

The increased breakage at the higher pressures, with the consequent loss of time of the drill runner in changing or repairing the machine, would tend to reduce the factor of desirability, as this item of expense is not included therein.

The increased breakage of drill steel would tend to limit the pressure, although there are not sufficient data on this point to determine the maximum. (Abstract of paper presented at the New York Meeting of the *American Institute of Mining Metallurgical Engineers*, Feb. 1921, 14 pp. and 14 tables, *e*)

ENGINEERING MATERIALS

EFFECT OF TEMPERATURE, DEFORMATION, GRAIN SIZE AND RATE OF LOADING ON MECHANICAL PROPERTIES OF METALS, W. P. Sykes. Researches conducted at the National Lamp Works to establish the relations existing between temperature and mechanical properties in molybdenum, nickel, and an aluminum-copper alloy. The molybdenum used was of the quality that is drawn into wire 0.003 in. in diameter for use as filament supports in incandescent lamps, and its chemical analysis showed less than 0.1 per cent of impurities. The nickel was obtained as 0.09-in. wire, annealed, of composition 99.8 per cent nickel and 0.15 per cent iron. Finally the alloy samples contained 3 per cent copper, 0.42 per cent iron, and 0.21 per cent silicon. Seven specimens of molybdenum, five of nickel and seven of the aluminum-copper alloy were tested. The individual specimens of each class were heat-treated and prepared in different ways.

Measurements were made of the tensile strength, reduction of area and elongation at temperatures varying from —185 to 1000 deg. cent. in the case of the molybdenum samples, and from —185 to around 600 deg. cent. with the nickel and aluminum-copper specimens. The results obtained are given in the original paper in separate tables for each specimen tested. Sets of curves are also constructed indicating temperature against tensile strength, elongation and reduction of area in each case, and photomicrographs of the metals at the place of rupture are analyzed and interpreted.

The following general conclusions are formulated:

Excluding allotropic changes and other specific characteristics, all metals possess the same fundamental properties and those exhibited by any one metal are functions of the temperature at which the observations are made. The maximum reduction of area by fracture in tension occurs in a piece of metal in which single grains occupy the entire cross-section. In the case of two aggregates, the one of smaller grain size suffers the greater reduction. The ultimate result of decreasing temperature is a complete loss of ductility and probably eventually a reduction in tensile strength. Brittleness is first observed in metals having equiaxed structures.

The smaller the grain size of a sample the lower is the temperature to which ductility is preserved. Deformation of a metal below its annealing temperature makes its maximum ductility at any temperature below that of working less than that of the same metal in the unworked condition. But the worked sample will retain its power of elongation to a lower temperature. (Abstract of paper presented, before the *American Institute of Mining and Metallurgical Engineers* at the New York Meeting, Feb. 1921, 35 pp., 38 figs., c)

Tests at Mellon Institute on Heat-Insulating Materials

Characteristics of 85 Per Cent Magnesia as a Non-Conducting Covering, Edward Weidlein. The data presented in this report were obtained during the course of an investigation conducted for the Magnesia Association of America by the Mellon Institute of Industrial Research, where the author holds the position of associate director.

The object of the investigation was to obtain facts regarding the

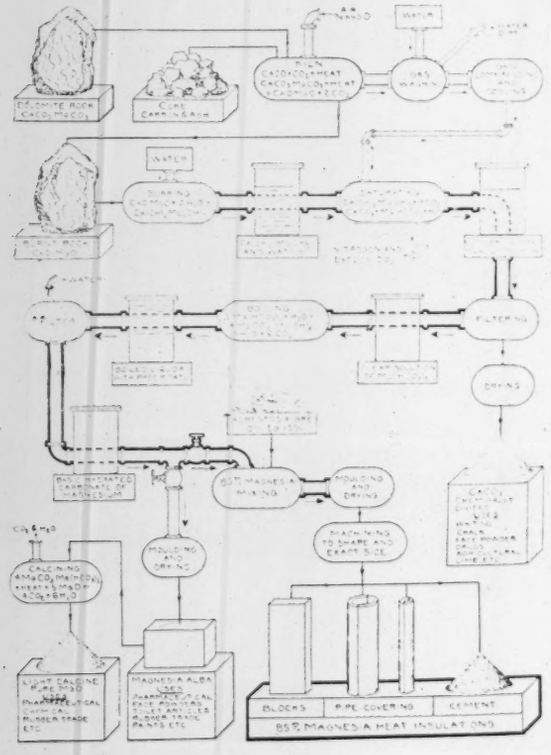


Fig. 2 Flow Sheet Showing Steps in Production of 85 Per Cent Magnesia

value of 85 per cent magnesia as a heat-insulating material. It is stated that the name "85 per cent magnesia" denotes the fact that the covering contains 85 per cent of basic magnesium carbonate. The remaining 15 per cent is asbestos, which is introduced as a binder to insure the required structural strength and durability. The flow sheet shown in Fig. 2 illustrates the method of manufacturing this product. The value of 85 per cent magnesia as a heat-insulating material is increased greatly by the interlacing and felting together of the crystals to produce a block of magnesia containing 90 per cent of voids, which take the form of exceedingly small air pockets.

At the Mellon Institute an investigation of heat loss from bare pipes was carried out with the results given in Fig. 3, where the full curves show heat losses from bare pipes as predicted from Péclet's formula, and the dotted curve and points indicate the experimental results obtained by various investigators. The Péclet values agree closely with the experimental findings and can be used safely.

Fig. 4 gives results of tests with pipes insulated with five different makes of magnesia coverings in 1-in., 2-in. and 3-in. thicknesses. The comparison with Fig. 3 will show a striking contrast between the losses from the bare pipe and the losses from covered pipes, and the difference increases with the temperature because the loss from bare pipe increases much more rapidly in proportion than the loss from covered pipe.

Further tests have shown that if the covering is alternately wetted and dried, the average value is the same before and after wetting and drying, and the treatment apparently does not effect the mechanical strength of the covering.

Tests on several old magnesia coverings have shown that the heat-insulating capacity slightly increases with time in some cases, and falls off materially in other cases, this latter taking place particularly where the covering happened to be saturated with oil.

As regards the influence of covering on rusting of steam pipes, the results of tests indicate that pipe coverings in general, especially if alkaline in composition, do not of themselves promote rusting on steam pipes when they become wet. On the contrary, they are claimed to act as a protecting coating since the oxygen does not get into intimate contact with the surface of the pipe. But an electric current flowing through the covering may either promote rusting of the pipe or it may retard corrosion, depending on the direction in which it is flowing. The greater the current flowing the greater will be the rusting effect. (Paper presented at the recent New Orleans Meeting of the American Institute of Chemical Engineers, abstracted through *Heating and Ventilating Magazine*, vol. 18, no. 2, Feb. 1921, pp. 30-34, 11 figs., eA)

Static and Dynamic Tension Tests on Nickel Steel, J. J. Thomas and J. H. Nead. Experimental investigation at Watertown Arsenal, Watertown, Mass., of the relation between static

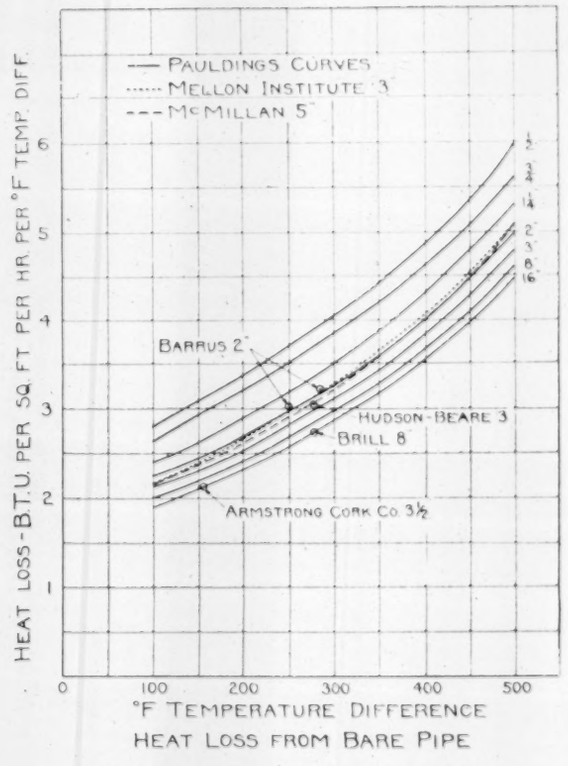


Fig. 3 Curves of Heat Losses from Bare Pipes

and dynamic tensile tests as measured by the work required to break test specimens slowly in a tensile testing machine, and rapidly by means of a falling weight. It was desired to ascertain the part played by ductility under different rates of application of load.

Five pieces of nickel steel, 0.505 in. in diameter and 10 in. gage length, containing 0.42 per cent carbon, 0.48 per cent manganese, 0.09 per cent silicon, 0.035 per cent sulphur, 0.035 per cent phosphorus, and 3.20 per cent nickel, were used. One piece was annealed, one was oil-hardened, and three were hardened and

drawn to different degrees. These five pieces, representing steels of varying hardness, were then tested slowly in tension and the stress-strain diagram plotted. Five similar pieces were also tested in an impact machine with a recording device for drawing the stress-strain diagram.

From tables in the original article it appears that both the specimen that was quenched but not drawn, and the one that was drawn up to 300 deg. cent., required very little work to break under either a radidly or a slowly applied load. The figures obtained for elongation and reduction of area indicate that ductility is independent of the rate of application of the load. Comparing the corresponding values of work under the two tests, it is concluded that as the elongation is about the same and the work is noticeably greater, the resisting force of the metal is greater for suddenly applied loads.

For low drawing temperatures both ductility and work of rupture are very low. As ductility increases the work of rupture

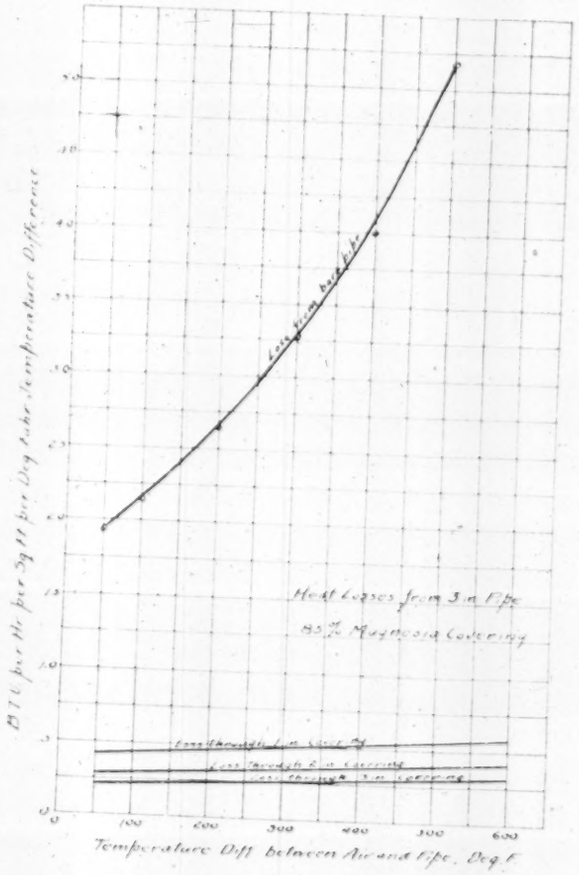


FIG. 4 CURVES OF HEAT LOSSES FROM PIPES INSULATED WITH 85 PER CENT MAGNESIA

increases. For hard steels, a small force, less than the elastic limit, if applied with sufficient velocity, develops enough kinetic energy to cause rupture. It is evident, therefore, that force alone is not the proper criterion by which to measure the strength of material. The work unit is more valuable as a measure of strength, and as ductility is an indication of the work required to rupture it is wise to specify a high ductility for all parts subject to shock. Ductility as measured by elongation and reduction of area in the ordinary tension test is important not for the part it itself plays but as an indication of strength as measured by work units. Steel is in its best condition when quenched and drawn just under its critical temperature.

The results of the static test demonstrate that for a slowly applied load nickel steel is hard and brittle when drawn at temperatures of 300 deg. cent. or lower. Beyond this point, however, a real softening effect is obtained. For low drawing temperatures the maximum strength, yield point, and elastic limit, occur at the same point, thus giving a brittle steel that fails without warning. This may be due to internal strains that have not been removed, or to the hard martensitic structure of the steel. For higher drawing temperatures there is a marked increase in the ductility and a greater resistance to shock. The modulus of elasticity increases slightly with the higher drawing temperatures, but this increase is probably too slight to have a commercial value. (Paper presented before New York Meeting of the *American Institute of Mining and Metallurgical Engineers*, Feb. 1921, 13 pp., 19 figs., *e*)

FUELS AND FIRING

CATALYTIC HEATING. R. Villers. Description of a device employing flameless combustion and designed by two French engineers, Louis Lumiere and J. Herck.

In this apparatus gasoline is used as a fuel and is decomposed by catalysis into water vapor and carbon dioxide, platinum in the presence of air being used as a catalyzer. The first employment of these heaters was found on military aeroplanes in winter when it was necessary to keep the water in the radiator warm and when it was not desirable to use an open flame because of the danger of fire. The construction of the device is diagrammatically shown in Fig. 5. A layer *A* of asbestos impregnated with platinum serves as the base of the cone *B* held by its small end against a similar cone *C*, which, in its turn, forms the top of a reservoir *D*. This reservoir is filled with a spongy material, such as cotton, which, by absorbing the gasoline prevents there being an excess of the liquid. A wick *E* extends into this reservoir and causes the evaporation of the liquid into the chamber between the walls of the upper cone and the platinized asbestos *A*. Once started by heating the platinized asbestos to the proper temperature, the action continues indefinitely as long as there is fuel, and produces a temperature of about 250 deg. cent. (482 deg. fahr.) in the top layer.

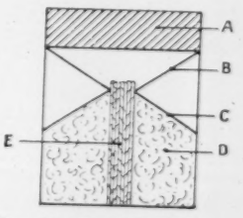


FIG. 5 THERMIX CATALYTIC HEATER

The preliminary heating of the platinized asbestos required to start the operation of the device may be accomplished by putting a few drops of gasoline or alcohol upon it and lighting them, or by an electric resistance. The advantage claimed for this device lies in the fact that the combustion takes place without the production of any flame, odor, or exhaust products, in addition to which the efficiency of combustion is very high because of the fact that the gasoline is decomposed completely without any residue and is claimed to develop its entire heating value without any losses. To extinguish the heater, all that is necessary to be done is to shut off the admission of air by means of a special cover.

The apparatus designed in accordance with the principle explained above has been placed on the market in France under the name of "Thermix." (*La Nature*, no. 2438, Dec. 25, 1920, pp. 415-416, 5 figs., *d*)

Furnace in which Air is Forced Between the Bars

THE TURBINE PATENT FURNACE. Description of a furnace designed on the principle of the impulse turbine. In its construction the air trough corresponds to the nozzle and the fire bars to the blades of the turbine. The air for combustion is forced between the bars which offer but slight resistance and the design is such that each fire bar receives an equal amount of air which is distributed through the narrow air spaces in the form of fine spray. Fig. 6 shows the furnace applied to a Babcock water-tube boiler. Its outstanding feature is the dead plate (7 in the figure) which slopes downward, thus bringing the furnace from 3 in. to 5 in. lower than the ordinary level and giving more room for combustion in the furnace proper. Air is admitted through the chamber as required, through the door fixed under the first bridge. The fire bars are constructed with interlocking lugs so that they cannot be displaced by the rake, and the air spaces slant upward and backward, reducing the amount of fine ash or coal that drops through to

a minimum. The bottom lugs project forward and intercept the air, thus insuring an evenly diffused supply throughout the fire. The grate consists of from four to six furnaces, each receiving its own air supply, which besides insuring an evenly burning fire makes the use of steam jets for creating the draft very simple.

TABLE 1 DATA OF COMPARATIVE TESTS OF TURBINE PATENT FURNACE AND FURNACE WITH ORDINARY FIRE BARS

Type of Furnace	Ordinary Bars	Turbine Furnace Bars
Duration of test, hr	6	6
Fuel average, lb. per hour	1,045	1,506
Ash, per cent	17.8	16.0
Total water evaporated, lb	25,800	50,800
Average steam pressure gage, lb. per sq. in	152	157
Average feed temperature, deg. fahr	210	250
Lb. water per lb. fuel as fired	4.11	5.63
Lb. water per lb. fuel from and at 212 deg. fahr	4.34	6.00

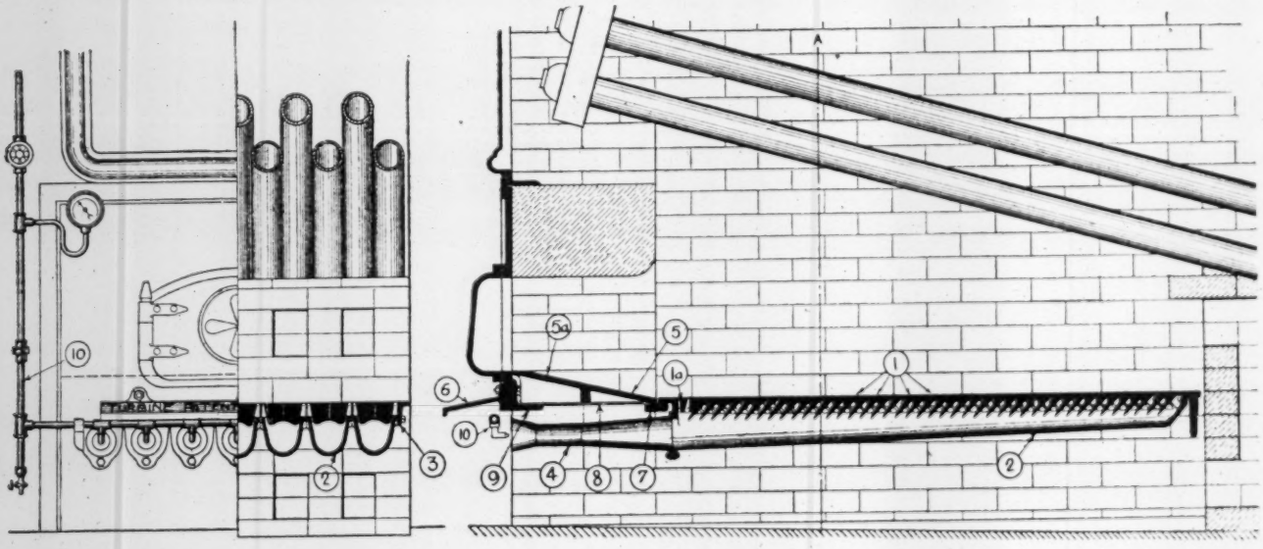


Fig. 6 Turbine Patent Furnace as Applied to a Babcock Water-Tube Boiler

Table 1 is claimed to represent results of a comparative test of the turbine furnace and ordinary fire bars carried out recently at the Birmingham Works of the General Electric Company. (*The Electrical Times*, vol. 59, no. 1525, Jan. 6, 1921, p. 11, 2 figs., *d*)

HEATING AND VENTILATION (See Engineering Materials)

HYDRAULIC MACHINERY (See Lubrication)

INTERNAL-COMBUSTION ENGINES

The Carbonization of Lubricating Oils in Internal-Combustion Engines, Frederic H. Garner. The mechanism of carbonization of oil is described by the author as follows: The major part of the oil getting into the combustion space is probably present as a fine spray. The heat of the explosion may be sufficient to completely burn the smaller droplets, but the larger droplets will be only partly burned by the momentary heat of the explosion. Thus carbon and asphaltenes are formed from the oil. If the carbon so formed is light in texture, it will be blown out of the exhaust, but if dense asphaltic material is formed in the ensuing compression stroke, it will tend to adhere to the piston face and cylinder walls, giving carbon deposits.

This makes the suction stroke the most important of the whole cycle from the point of view of lubrication, as the leakage of oil occurring during the stroke is the origin of the carbon deposit. On the other hand, as carbon formation is determined mainly by the character of the oil spray in the combustion space rather than the oil film on the walls, the rapid carbonization of oil, that is, its coking value, will be a more important factor in the testing of lubricating oils for internal-combustion engines than the gradual carbonization at lower temperatures.

In an investigation carried out by the writer the evaporation losses and degree of carbonization over a wide range of temperatures were determined for a series of lubricating oils from petroleum representing asphaltic and paraffin-base crudes, and the means used in the investigation are described in some detail. (*Petroleum Times*, vol. 5, no. 107, Jan. 22, 1921, pp. 93–95, *e*)

LUBRICATION (See also Internal-Combustion Engines)

Lubrication of Hydraulic Turbines, Niagara Falls Power Company. The lubrication of the recently installed hydraulic turbines of the Niagara Falls Power Company is of great interest both because of the tremendous size of the units and because of their modernity. There no striking novelties of any kind, but the installation is of interest as one in which great care has been taken to create the best possible conditions of lubrication. Special attention is called to the method of using oil in the governors.

In these turbines the thrust and upper guide bearings are supplied with oil by separate pipes leading from a storage tank of 2000 gal. capacity in the upper part of the power house, the feed to the bearings being by gravity. The pressure obtained is not only sufficient but actually somewhat excessive and a regulating valve and oil meter are installed in the thrust-bearing line to regulate the supply. After passing through the bearings the oil from all the sets runs to a common header and thence to the filtering system. An oil of 180 sec. (Saybolt) viscosity at 100 deg. fahr. has been found suitable for the bearings, but it must be kept so as to be non-emulsifying with water and not to break down on continual use. It is stated that the oil and bearings have been so thoroughly developed that the oil emerging from the thrust bearings shows a rise in temperature at full load of only 6 deg. fahr. and the loss in power due to bearing friction is only 26 hp. or seven hundredths of one per cent of the power of the unit.

Another place where oil is used is in the governors which control the amount of water flowing into the turbines. This control is effected by 20 swinging guide vanes situated around the circumference of the runner. These vanes are operated by means of a ring which in turn is actuated by pistons in large cylinders. The displacement of these pistons is controlled by a governor.

Originally oil was used as the actuating medium in these pistons, but as it is almost impossible to prevent leakage, not only was a large amount of oil wasted but the compartment where the gates were installed soon became slimy and unsightly. This condition was obviated by using a mixture of soluble oil and water in place of oil alone. It was found that a one per cent mixture of soluble oil in water was sufficient to furnish adequate lubrication to the moving parts and prevent rusting and corrosion of the metal. (*Lubrication*, vol. 6, no. 11, December 1920, pp. 1–8, 9 figs., *dg*)

Chemistry of Lubrication—The Deeley Oil-Testing Machine

FRICTION AND LUBRICATION, R. Mountford Deeley. Description of experiments on lubrication and of a special machine designed by the author for testing oils, accompanied by general remarks on the mechanism of the phenomena of lubrication.

The friction experiments described in the article were made under conditions which insured that the surfaces should be in actual contact, and it is claimed that any differences in the frictional coefficients shown by the oils tested must have resulted from the contact of oily metals, and not from the free molecules of the liquid itself. The experiments were made with the machine shown in Fig. 7.

Three pegs, each $^5/_{32}$ in. diameter, rested upon the flat surface of a disk of metal which could be slowly rotated. These pegs were secured concentrically to an upper disk which could be weighted as desired and which actuated a spindle to which a spiral spring and recording finger were attached. When the lower disk was rotated the pegs were carried with it by friction until the surfaces slipped owing to the stress on the spring, and the finger then gave the value of the frictional stress reached. To damp the oscillations of the finger the spindle to which the finger and spring were attached was geared to a small train of wheels, the freely revolving end wheel of the series having a weighted rim to increase its inertia. When measuring the static coefficient a pawl and ratchet were thrown into gear with the indicating finger to prevent it from moving toward zero if an oil film should form and the surfaces part. By very slowly moving the driving handle the finger was quickly brought to the position giving the static coefficient. The movable disk upon which the pegs rested lay in a circular dish, which could be filled with oil and slowly rotated.

To insure clean surfaces the metals were ground in water with flour of carborundum and then carefully polished and dried. Such clean surfaces are very sensitive to any contaminating agency.

One of the interesting things found was that while animal and vegetable oils largely displaced mineral oils from surfaces, mineral oils would not displace animal or vegetable lubricants. Surface may be contaminated with oil and yet not be wet. The coefficient of friction—static—varies very much with the condition of polish of the surfaces, as well as with the nature of the contamination.

When the surfaces are properly ground and polished and no lubricant is used, the static coefficient becomes greater and greater as the surfaces continue to rub against each other.

The tests have shown that the friction depends not only on the oil used but on the metals.

Table 2 gives the static coefficients and efficiencies of a number of oils tested between mild steel and cast iron and mild steel and gun metal. The percentage efficiency e has the value

$$e = 100 - (\text{static coefficient} \times 100).$$

There is a marked difference between the friction of the various oils when the mild steel is opposed respectively by cast iron and gun metal. Rape and olive oils give the best results and mineral oils the worst, castor coming between the mineral lubricants and the rest. Rape and olive are of equal value between mild steel and cast iron, but rape is the better between mild steel and gun metal.

TABLE 2 COEFFICIENTS OF FRICTION AND EFFICIENCIES OF VARIOUS LUBRICANTS

	Mild steel on cast iron		Mild steel on gun metal	
Lubricant	Static coefficient	Efficiency, per cent	Static coefficient	Efficiency, per cent
Clock oil	0.271	72.9	0.275	72.5
Bayonne	0.213	78.7	0.234	76.6
Typewriter	0.211	78.9	0.294	70.6
Victory red	0.196	80.5	0.246	75.4
F.F.F. cylinder	0.193	80.7	0.236	76.4
Manchester spindle	0.183	81.7	0.262	73.8
Castor	0.183	84.7	0.169	83.1
Sperm	0.127	87.3	0.189	81.1
Trotter	0.123	87.7	0.152	84.8
Olive	0.119	88.1	0.196	80.4
Rape	0.119	88.1	0.136	86.4

The value of such a test as an indication of the lubricating value of an oil depends entirely upon the mode of preparing the surfaces.

The author comes to the conclusion that the oil film formed between the metals is really a combination between the molecules of the lubricant with the molecules of the metallic surfaces. He believes it is possible that the molecules of a liquid lubricant or those of a lubricating grease penetrate the metal for some considerable distance and form on its surfaces a comparatively thick film of a compound which acts as a lubricant.

In his estimation the unsaturated molecules of the lubricant seem to attach themselves to the molecules of the metals they wet and form skins capable of preventing the free molecules of opposing metallic surfaces from adhering. If such be the case it is reasonable to suppose that friction coefficients between such metallic skins would vary with the metals in contact as well as with the nature of the oil. (Preliminary Report communicated to the Lubricant and Lubrication Inquiry Committee of the Department of Scientific and Industrial Research, Dec. 5, 1918. Not previously published. Abstracted through *The Engineer*, vol. 131, no. 3395, Jan. 21, 1921, p. 78, 1 fig., *et al.*)

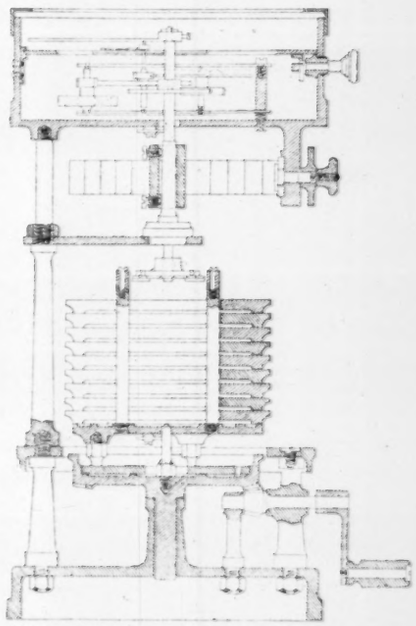


FIG. 7 DEELEY OIL-TESTING MACHINE

In connection with the foregoing abstract it is desirable to call attention to an editorial in the same issue of *The Engineer*, p. 74, under the title, Is Lubrication a Chemical Phenomenon?

In this editorial is reported a statement made by Mr. Deeley personally to the writer thereof to the effect that the oil film which he considers a compound formed by the oil with the metal is not a mere mixture or interlacing of the molecules, but is a definite union attributable to the action of the interatomic forces. In other words, it completely and exactly fulfills our conception of a chemical compound and in the case of a fatty lubricating oil may conveniently be referred to for purposes of discussion as oleate of iron, copper, cupro-tin, etc.

In this connection it is to be noted that common soap is formed by the union of fatty acids with sodium or potassium. The alkali can, however, be replaced by various other metals. Thus "soaps" formed by the union of fatty acids with iron, nickel, cobalt, zinc, magnesium, aluminum, copper or mercury are possible, and are actually made and used for a wide range of industrial purposes. The suggested union of the oily molecules with the molecules of the contacting surfaces in a partially lubricated bearing is thus not a chemical absurdity so long as we confine ourselves to animal or vegetable oils. In the case of mineral lubricating oils, however, the nature of the suggested compound is less readily pictured, although it is possible, by means of Mr. Deeley's theory, to propound an explanation of the facts reported by Messrs. Wells and Southcombe—in support of their "germ" theory—regarding the addition of small quantities of free fatty acid to mineral lubricating oils which was described by them in a paper before the Society of Chemical Industry (*Journal of the Society of Chemical Industry*, cp. MECHANICAL ENGINEERING, June 1920, p. 356).

MACHINE PARTS (See also PUMPS)

Locking Ratchet Device for Trolley-Car Brake Handle

The Thomas Patent Ratchet Device. One of the important parts of equipment which have undergone no improvement since the horse-car days is the locking ratchet device at the bottom of the driver's brake handle. The original method of kicking a dog or pawl into gear with the ratchet wheel at the bottom of the brake spindle is still universally employed. A new type of this device is shown in Fig. 8. It consists of the usual ratchet wheel, keyed on to the brake spindle, but instead of the teeth being on the side or edge of the wheel as at present, they are on the top and are of the rack type. Engaging in this wheel is a four-tooth dog wheel or pawl, which is held in position by a coil spring surrounding the brake spindle, and prevented from rotating by projections which engage lugs on the inside of the casing. To apply the brake on a car fitted with this new device, it is only necessary to turn the brake in the "on" position. A foot pedal (almost flush with the floor) operates a fork, which lifts the four-toothed wheel or pawl free of the ratchet wheel, thereby allowing the brake gear to be released. This foot pedal can also be made to slide sideways instead of being pressed down. All this gear is encased in a dust-and-grease-tight box, which insures protection from dirt. This fitting can be adapted to suit the double-spindle type brake gear largely used on various tramways.

It is claimed that this brake ratchet enables the driver to apply his brakes more quickly and to "feel" the brakes better, thereby reducing the wear and cost of brake shoes and wheel tires, and also preventing skidding of wheels. In case of emergency the driver can devote his entire energies to applying the brake, without having to worry about engaging the ratchet dog and pawl with his foot, as at present. Since the ratchet wheel is held by four ratchet dogs or pawls instead of one, as at present, the risk of the brake gear being released through wear is reduced. The foot pedal is provided with a cover to prevent passengers treading on it, thus releasing the brake gear when the car is at rest. The ratchet device thus presents very marked advantages over the existing type and it is anticipated that it will be widely adopted for tramway hand brakes. In this connection the device illustrated, which was developed in England, is of interest. (*The Tramway and Railway World*, vol. 49, no. 3, Jan. 13, 1921, pp. 25–26, 1 fig., *d*)

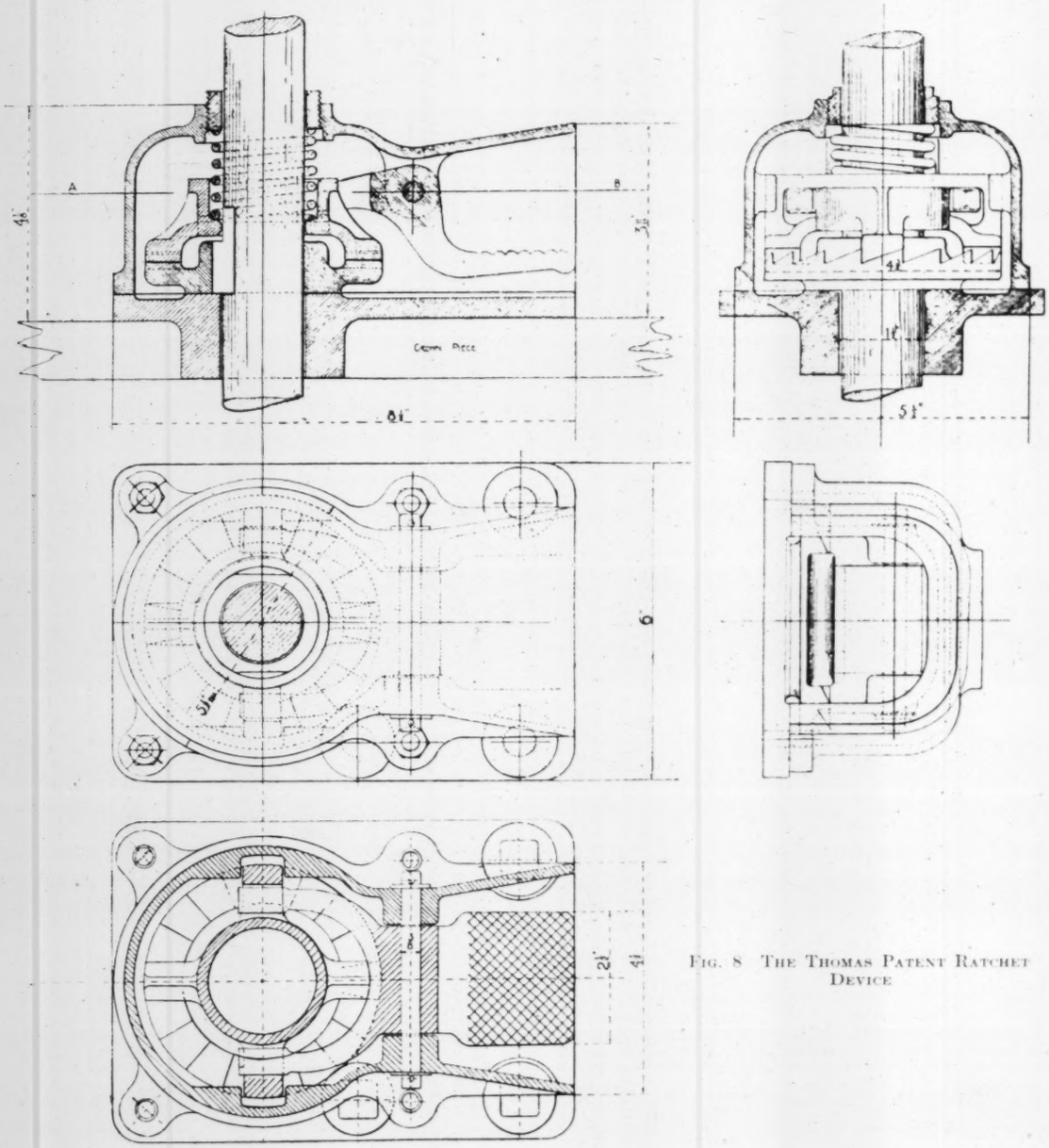


Fig. 8 The Thomas Patent Ratchet Device

There has been some decline in the use of vanadium in automobile steels, but experiments made with the metal in the production of high-grade non-ferrous alloys are reported to have been highly successful.

MACHINE SHOP

ELECTRIC RIVET HEATERS. During the war both in this country and in Europe several types of electric heaters were developed. Such heaters work somewhat like electric resistance-welding machines and consist essentially of a static transformer furnishing a heavy current at a low voltage (in America, 5 and 2½ volts), and means for holding the rivets. The heating takes place with great rapidity, but in order that there may be no delay the machine is designed to take two or three rivets at once, so that there is always at least one fully heated rivet ready for use. In some ways the three-rivet machine has an advantage over the two-rivet, since with three sets of electrodes rivets can be placed and removed when they are hot without having to operate a switch, as the two rivets which remain in position insure that the circuit is not actually broken.

In British machines plug switches are used to obtain the proper currents for each size of rivet. With a little practice the operator soon acquires the knack of putting the plugs in the proper holes for the particular class of rivet to be heated. It is stated that steel rivets $^5/_{16}$ in. in diameter can easily be heated at the rate of 1000 per hr. and $^1/_2$-in. diameter rivets at the rate of 600 per hr.

Table 3 is of interest as showing the output and power consumption with rivets of various kinds. (*The Railway Engineer*, vol. 42, no. 492, Jan. 1921, pp. 23–24, 1 fig., *de*)

TABLE 3 OUTPUT AND POWER CONSUMPTION OF ELECTRIC RIVET HEATERS

Rivets	Output per Hour	Maximum Power
$^5/_{16}$ in. × $^5/_8$ in.	600	6 kw.
½ in. × 1 $^1/_{16}$ in.	250	
$^9/_{16}$ in. × 1 $^1/_8$ in.	100	
$^5/_{16}$ in. × $^5/_8$ in.	600	12 kw.
$^3/_8$ in. × 1 $^1/_{16}$ in.	700	
$^9/_{16}$ in. × 1 $^1/_8$ in.	300	
$^9/_{16}$ in. × 1 $^1/_8$ in.	500	20 kw.
$^3/_4$ in. × 2 $^1/_8$ in.	220	

Hack-Sawing Machine of Novel Design

NEW HACK-SAWING MACHINE. Description of a power hack saw recently placed on the market by an English firm. The machine is very heavy, having a weight of 580 lb. and is designed to cut bars up to 6 in. in diameter.

The cut takes place on the backward or draw stroke, feed being effected by an adjustable weight carried on the top of the extended arm. On the forward, non-cutting stroke, the saw is relieved in a somewhat unusual manner. As seen in the arrangement, Fig. 9, the extended arm *B*, on which the saw frame is carried, is suspended by means of a roller chain from a spring-loaded drum *A*. Around a portion of this drum a number of fine ratchet teeth are cut, which are alternately engaged and disengaged with a pivoted pawl seen on the under side. During the forward, non-cutting stroke, the two members are engaged, consequently the drum is locked, the attached roller chain holding the extended arm stationary, and the saw is clear of the work. At the end of the stroke the pawl is disengaged, which allows the drum to be turned sufficiently to lower the frame on to the work, when the cut is freely effected, due to the weight mentioned. The alternate engaging and disengaging of the pawl is effected by means of a cam mounted on the crank driving shaft, which is in contact with a roller (not shown) carried in the rocker arm *C*. During the forward stroke the rocker arm is raised, and by reason of unequally weighted ends the pawl, pivoted thereon, drops into engagement, thus locking the drum and transferring the lifting to the saw frame. As the rocker arm is lowered at the end of the stroke, the outer end of the pawl makes contact with the adjustable stop *E*, Fig. 9, and is thus tilted clear and releases the drum. The drive, as mentioned, is by tight and loose pulleys, which replace the usual dog-tooth driving clutch. At the end of a cut the belt is automatically moved over on to the free pulley, thus stopping the machine. The belt fork is attached to a tension spring, which always tends to draw it over to the free pulley side. On moving over the belt fork by hand to start the machine, it is retained in position by a catch and is released at the completion of a cut through an abutment striking the lower end of the catch as the frame drops forward. (*Machinery* (London), vol. 17, no. 435, Jan. 27, 1921, p. 524, 2 figs., *d*)

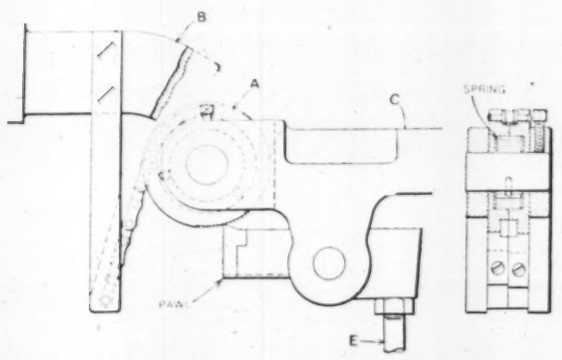


FIG. 9 NEW HACK-SAWING MACHINE. GENERAL ARRANGEMENT SHOWING METHOD OF RELIEVING SAW DURING THE FORWARD, NON-CUTTING STROKE

MACHINE TOOLS

British-Made Full-Automatic Screw Machine

THE "EMPIRE" FULL-AUTOMATIC SCREW MACHINE. Description of a small automatic machine of British design and manufacture, an unusual feature of which is that it can be set up to produce two pieces for each complete revolution of the camshaft, thus doubling the capacity. A full description, however, cannot be given here, as the illustrations are not suitable for reproduction.

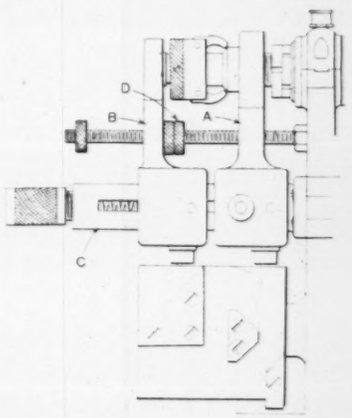


FIG. 10 STOCK-FEED MECHANISM OF THE "EMPIRE" AUTOMATIC SCREW MACHINE

The stock-feed mechanism is shown in Fig. 10. The collet is of the push-to-close type, and is controlled by the usual fingers and coned sleeve. This is operated by the bracket *A*, in turn controlled by the cams on the cam drum immediately below. The feed fingers in the spindle are operated by the bracket *B*, which is kept pressed toward the headstock by a spring housed in the bracket carrier *C*. The stock-feed cam on the cam drum thus draws the feed fingers back over the stock against the spring in *C*, and the nut and lock nut can be set to control the extent of the return movement, and consequently the amount of stock fed; the adjustment of the nuts *D* can therefore be used in certain cases instead of a stop in the turret, leaving all six turret stations free for tools.

Very effective overrunning die and tap holders are supplied for use in the turret; in addition to releasing in the usual manner, a spring blade bears on the holder and prevents rotation during withdrawal of the tap or die when the machine is reversed.

The machine throughout is substantial in design, and the idle movements of the turret cross-slide and reversing clutch are very rapid, allowing very close setting. If the machine is cammed for dealing with one piece per camshaft revolution, two threading operations can be undertaken, in addition to forming, drilling and parting, but where fewer operations are required the camming can be arranged to give two pieces for each camshaft revolution.

The gear train between the camshaft worm drive and the feed shaft from the planetary gear allows of ten feed changes, so that with the standard turret slide cams supplied a great variety of work can be undertaken. Setting up is very straightforward, and all adjustments can be made without going to the rear of the machine. By means of a double countershaft with cone pulleys, twelve spindle speeds are possible.

The capacity is up to $^1/_2$-in. stock, and the maximum length that can be turned is $1^1/_2$ in., although the maximum stock feed is $2^1/_2$ in. A pump, capacious suds tray and sump are provided.

The turret slide-cam drum has three T-slots, into which fit tenons turned out of the solid with the standard cams which are manufactured in ring form and afterward cut out as required. T-bolts secure the cams in the position desired, but the tenons take all side thrusts during operation and prevent the bolts from loosening.

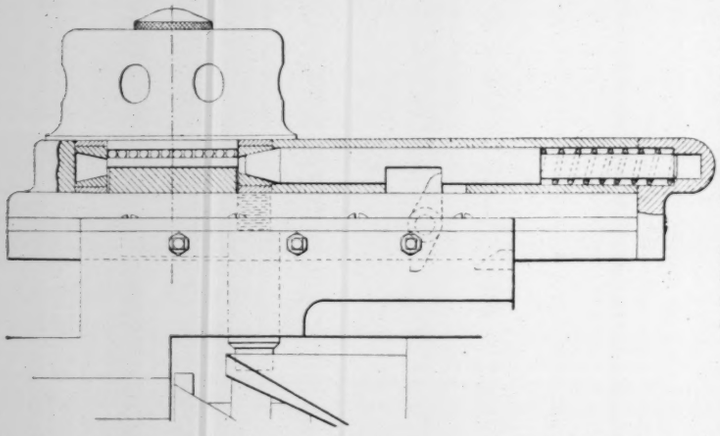


FIG. 11 TURRET INDEXING MECHANISM OF THE "EMPIRE" AUTOMATIC MACHINE

The turret indexing mechanism is shown in Fig. 11, and the substantial proportions and bearing surfaces of the indexing pin will be noted; the pin and indexing bushes are hardened and ground. The turret is supported below by a ball-bearing thrust washer. The cross-slides are positively advanced by cam levers and standard cams secured to a cam disk immediately below; the front and rear slides are independent and are spring-returned. (*Machinery* (London), vol. 17, no. 434, Jan. 20, 1921, pp. 492–493, 5 figs., *dA*)

Large Form-Grinding Machine

BRYANT FORM-GRINDING MACHINE, Ellsworth Sheldon. This machine is said to be capable of regularly grinding pieces 10 in. long and of any diameter up to 12 in., by feeding the wheel straight toward the center of the work with a traverse of only $^1/_8$ in., and even this slight movement may be dispensed with, if necessary.

The machine is a development of the "bar" type, but the usual principle has been reversed. The bar carries the work and the wheel is mounted upon the bed in a stationary position. The wheel head when once set for the work in hand has no further movement until wheel wear makes it necessary to reset it. The movement of the work toward the wheel, the feed movement, is obtained by swinging the work carrier which is suspended from the bar.

Not only are cylindrical pieces of work reduced sufficiently to remove irregularities and make them round and smooth, but work having several diameters is produced with almost equal facility, each piece being exactly like every other piece and finished in a matter of seconds as regards grinding time and to limits of accuracy comparing favorably with other grinding methods.

Fig. 12 shows the various movements of the machine. The work centers are carried in the frame *AA* suspended from the main bar *B*, which latter is the feature that gives to the Bryant type of machine its name. The center at the driving end does not revolve, nor has it any adjustment endwise, except as the whole frame is moved. The rear spindle, which is a sleeve, may be adjusted longitudinally for a distance of 12 in. to accommodate various lengths of work and, in whatever position it may be, is firmly clamped to the lower member of the frame *AA*, the latter corresponding to the cross-slide of other types of machine.

An inner spindle, carrying the tail spindle, has a limited movement endwise for the purpose of mounting and demounting the work. This movement is controlled by the lever *C* through a spring-supported cam that holds the tail center strongly in place, while still allowing it to recede as the work expands under the influence of the heat generated by the grinding operation.

The bar *B* slides, and also turns, in adjustable bearings supported by the frame of the machine. Telescoping sleeves upon the bar protect the bearings from dirt and particles of abrasive. Endwise movement of the bar, of course, causes a traversing movement of the work across the face of the wheel, and the swinging movement provides for feeding the work to the wheel.

The bracket *D* is permanently fastened to the base of the machine and carries the cross-feed screw and sizing mechanism. The inner end of the cross-feed screw carries a hardened bearing shoe, upon which rides a bearing bar fastened to the carriage and held at all times in contact with the shoe by heavy counterweights. A pawl engaging with the ratchet *E* automatically turns the latter forward until it is disengaged by a shield that partly covers the ratchet wheel. A graduated dial enables the operator to set the shield to disengage the pawl at any predetermined point.

The machine is semi-automatic in its operation in so far as, after the work has been ground to a specified diameter, the wheel is automatically withdrawn from the cutting position. This action insures a very close duplication of size, as the grinding time of the wheel, after it has reached a positive stop, is exactly the same

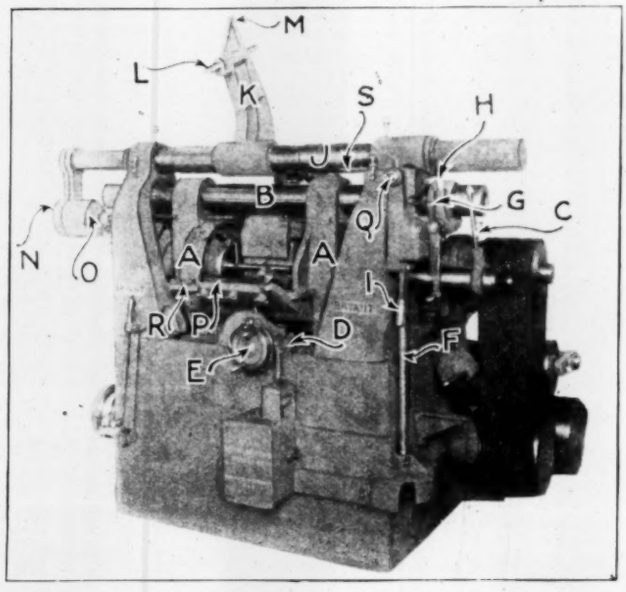


FIG. 12 BRYANT FORM-GRINDING MACHINE, FRONT VIEW

on every finished piece. That is to say, the length of time that the wheel is allowed to grind after reaching a positive stop for a set diameter is the same for each piece ground.

Traversing movement is transmitted to the bar *B* by means of an eccentric near the upper end of a vertical shaft, to be seen at *F*. The eccentric straps are connected to the clamping collar *G*, which may be tightened upon the bar by a movement of the operator's wrench upon the head of the clamping screw *H*. The squared projection upon which the crank wrench is shown in the picture is the end of a pinion shaft by means of which the operater may move the main bar by hand in either direction to any desired position, first loosening the clamping collar *G*. All wrench-operated parts of the machine are fitted by the one crank wrench.

Fastened to the front of the carriage at *P* and held thereto by the three large hand-operated clamping screws to be seen under the carriage is a bar about 12 in. long, the inner profile of which is an exact replica of that of the piece to be ground. This piece is called the master bar and is produced by toolroom methods, for upon its

accuracy depends the accuracy of the product. The machine has no control over *relative* diameters. Actual diameter of the work as a whole is completely under control of the operator through the cross-feed screw and sizing mechanism, but, if one diameter upon a stepped piece is too large or too small in relation to other diameters upon the same piece, the fault is in the master bar and must be corrected there. (*American Machinist*, vol. 54, no. 8, Feb. 24, 1921, pp. 305-308, 9 figs., *d*)

POWER PLANTS

NON-CONDENSING TURBINE PLANT OF THE WESTERN FELT WORKS. In felt works there is a considerable demand for steam for drying and heating, and when the company (located in Chicago) installed in the early part of 1920 two turbo-generators they made them non-condensing in order to satisfy the large and continuous demand for exhaust steam.

The two turbo-generators have capacities of 500 and 300 kw., respectively, at 80 per cent power factor, and supply three-phase 60-cycle cycle current at 220 volts.

As practically all the exhaust steam is utilized, the water rates are not of great importance, but the guarantees are as follows when the machines are supplied with steam at 150 lb. pressure and 100 deg. superheat: For the 500-kw. machine at one-half load, 40 lb., and for the full load of 500 kw., 37.1 lb. per kw-hr. For the smaller machine the water rates are 53.9, 45.1 and 40.9 lb. per kw-hr., respectively. (*Power*, vol. 53, no. 8, Feb. 22, 1921, pp. 294-297, 4 figs., *d*)

NEW HAMMERMILL PLANT. Description of a plant operated in conjunction with the paper mill of the Hammermill Company, Erie, Pa., the most interesting feature of which is that it employs superheated steam for both prime-mover operation and manufacturing processes.

There are four 500-hp. water-tube boilers, each built for 250 lb. gage pressure, though ordinarily operated at 235 lb. gage and equipped with superheaters for raising the temperature of the steam 150 deg. fahr. above that corresponding to the pressure. Whenever possible these units are worked at 175 per cent of their rated capacity, which has been found to be the loading providing the greatest overall economy.

In addition to superheated steam, saturated steam is also available for the operation of such auxiliaries as the stoker engines, pumps, etc. (*Power Plant Engineering*, vol. 25, no. 4, Feb. 15, 1921, pp. 201-204, 6 figs., *d*)

PUMPS

Formulas Dealing with Valves of Reciprocating Pumps

INVESTIGATION OF AUTOMATIC PUMP VALVES AND THEIR INFLUENCE ON THE OPERATION OF PUMPING MACHINERY. Ludwig Krauss, D.E. Notwithstanding the very extensive use of reciprocating pumps, no sufficient information is available for such design of valves as will prevent their knocking. It is with this in view that an investigation on the suction and pressure valves in pumps was recently undertaken in the machinery laboratory of the Technical High School in Dresden.

The experimental pump took water either from a suction tank 9.5 m. (30.2 ft.) below the pump or from a well of a turbine installation.

The construction of the pump shown in the original article does not represent anything unusual. It is a double-acting pump with an output of 120 cu. m. (4237 cu. ft.) per hr. at 75 r.p.m. and at a pressure head of 10 atmos. For test purposes it was rebuilt into a single-acting pump and so constructed that it was possible to change the spring arrangement on the valve while the pump was running and that the same amount of water could be handled at several speeds of the pump. This latter was achieved by using on the same piston rod pistons having diameters of 90, 118 and 140 mm. (3.54, 4.36, 7.5 in.).

Figs. 13 and 14 show the various valve-lift diagrams for the suction and pressure valve in triple magnification. The indicator drums were running at a uniform speed and as their speed of rotation could be measured, the velocities of valve lifts could be easily derived from the diagrams. Two other figures in the original article give the pressure-difference diagrams for the pressure valve and suction valve.

As regards the planning of the test, it was decided to determine the influence of such factors as agree in practice on the play of the valve, on the degree of delivery through the valve and on the indicated efficiency. The factors which were considered to be variable within wide limits were the delivery head, the volume of water handled and the load on the valve.

To determine the play in the valve, suction heads of 2, 4 and 6 mm. of water were employed and water admitted under a pressure of 2.5 atmos.; furthermore, the pressure head could be raised as high as 10 atmos.

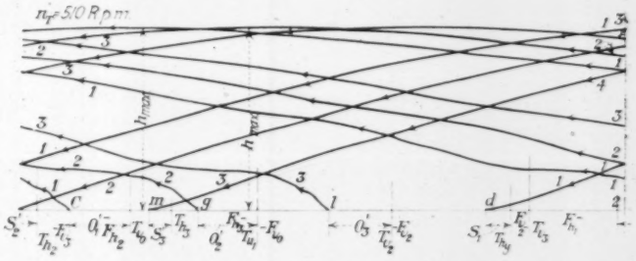


FIG. 13 PRESSURE-VALVE LIFT DIAGRAM

To determine the delivery, the volume of water handled was varied from 10 to 115 cu. m. (353 to 4060 cu. ft.) per hr. by varying the speed of rotation of the pump from 25 to 150 r.p.m. and then using four different pistons with areas of from 47.12 to 185.85 sq. cm. (7.2 to 28.6 sq. in.).

The data of the tests are presented in numerical form and also as curves.

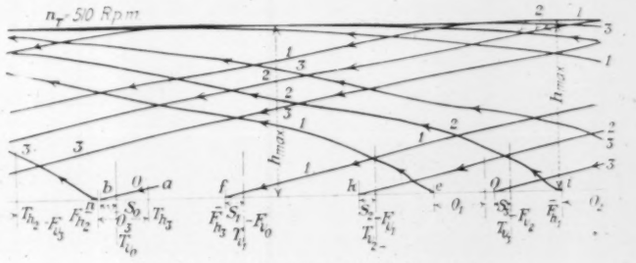


FIG. 14 SUCTION-VALVE LIFT DIAGRAM

The following represents the main general conclusions arrived at from the results of the tests:

Opening and Closing of the Valves. In general, it may be said that the valves have a tendency both to close and to open late. A valve does not open immediately after the closing of the opposite valve, but there is a lag which is greater in proportion to values of the suction head, the suction valve load and the speed of rotation.

Knock at Opening of the Pressure Valve. The strength of this knock is determined by the timing of the opening of the pressure valve and also by the delay in the closing of the suction valve. On the other hand, it is but little affected by the increase in load of the pressure valve and by increase in the pressure head as long as the operation of the pump is kept within normal limits. The knock is decreased by the unloading of the suction valve, whereby the suction capacity of the pump is increased, and by lack of tightness of the pressure valve. This is explained by the fact that after the closing of the suction valve a water-free space is formed under the pressure valve. As a result the water reaches the lower face of the pressure valve only a certain time after the reversal in the direction of the stroke, and does it with a blow, which, in the case of a pump running low, has a dull sound, and a poorly running pump a loud, hard, metallic sound.

Knock at Closing of the Pressure Valve. This knock is the louder the smaller the initial compression of the spring and the greater the maximum valve lift, but even with a large initial compression

of the spring and a slight valve lift it can be heard. It has not been found possible to locate a clearly defined point at which the pressure valve closes without a blow. Because of this, it is not possible to test the correctness of the Klein law, in accordance with which the product of the speed of rotation per unit of time times the maximum valve lift is a constant at the same valve load at the point where the closing of the valve takes place free of knock.

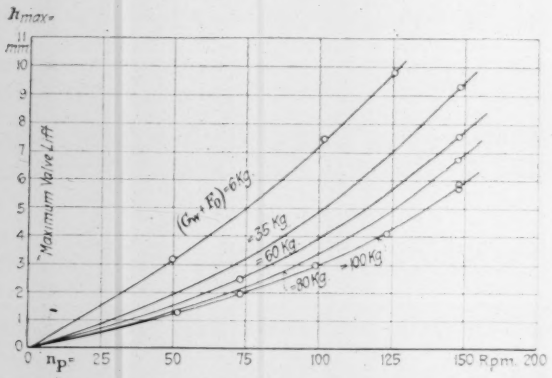


FIG. 15 VARIATION OF MAXIMUM VALVE LIFT WITH SPEED OF THE PUMP AND LOAD ON THE VALVE

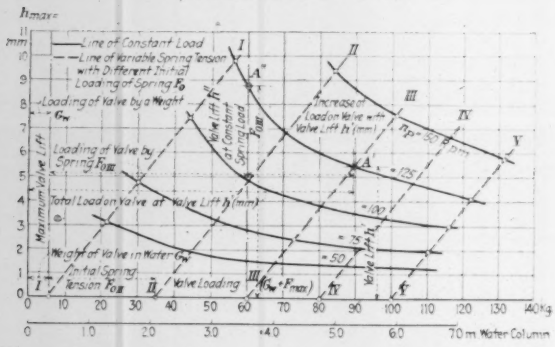

hmax=
mm
Line of Constant Load
Line of Variable Spring Tension with Different Initial Loading of Spring F0
Loading of Valve by a Weight Gw
Loading of Valve by Spring FIII
Maximum Valve Lift
Total Load on Valve at Valve Lift h(mm)
Weight of Valve in Water Gw
Initial Spring Tension F0II
Valve Loading (Gw+Fmax)
Increase of Load on Valve with Valve Lift h (mm)
np=50 Rpm.
=125
=100
=75
=50
Valve Lift h
I II III IV V
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140Kg
0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 m Water Column

FIG. 16 VARIATION OF MAXIMUM VALVE LIFT WITH SPRING TENSION ON THE VALVE AND SPEED OF THE PUMP

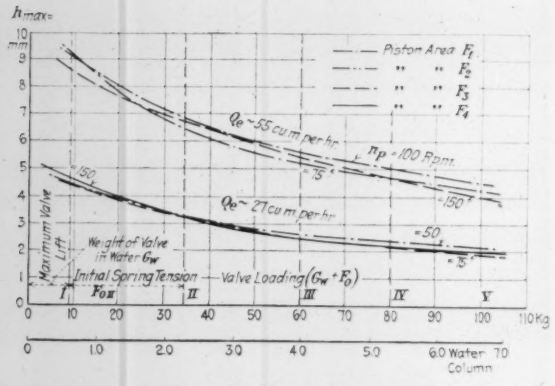


FIG. 17 VARIATION OF MAXIMUM VALVE LIFT WITH LOAD ON THE VALVE AND VOLUME OF WATER HANDLED PER UNIT OF TIME

The knock at the closing of the suction valve was under the same conditions and a normal valve clearance always found lighter than the knock in the closing of a pressure valve of the same construction, a fact which could be determined both by listening and from the measurement of the velocity of the valve closing.

Velocity (v_s) of Valve Closing. This was determined from the curves of valve lift and it was found that at quiet running v_s = 80 mm. (3.14 in.) per sec.; at ordinary running v_s = 100 to 120 mm. (3.9 to 4.7 in.) and at noisy running v_s is greater than 130 mm. (5.1 in.) per sec. These values can of course vary with individual valves.

The maximum lift h_{max} is a function of the volume of water handled, the load on the valve, and the dimensions and design of the valve, but is entirely independent of the pressure head employed.

Apart from the violent oscillations in the suction valve when the suction of the pump is poor, it is usual to make the maximum lift of both suction and pressure valves the same with the same spring load. If sufficient experimental information is available to determine the value of the coefficient of justification μ_P, then the maximum valve lift may be calculated with a precision sufficient for practical purposes from—

$$h_{max} = \frac{Q\pi}{\mu_P l \sqrt{2g \frac{P_{max}}{f\gamma}}} \quad [1]$$

where Q is the volume of water handled in cubic meters per second, l the length of the clearance in meters, P the load on the valve in kilograms, and f the free valve-seat area expressed in square meters.

It is impossible to express in a general manner the maximum value for h_{max} for any given case, but it can be determined by experiment and in the original investigation a table is given. This table is not reproduced in the article from which this abstract is made. By increasing the load on a valve the lift may be decreased simultaneously with the increase of the valve resistance. This can safely be done in the case of the pressure valve but not with the suction valve because it might produce in the suction valve a loud knock at the instant of opening the pressure valve, and the irregular operation of the valve.

In this connection the curves in Figs. 15, 16 and 17 are of interest, of which the first gives the values for the maximum valve lift for a given speed of the pump in revolutions per minute and for valve loads varying from 6 to 100 kg., all other conditions being the same. The next figure gives the maximum valve lift at a given load for speeds of the pump varying from 50 to 150 r.p.m., and finally the last of the three gives the maximum valve lift at a given load for volumes of water equal to 27 and 55 cu. m. per hr., respectively. From this last figure it would appear that, all other conditions being equal, the valve lift is mainly determined by the volume of water handled.

The second part of the article deals with various individual results obtained from the tests and may be abstracted in an early issue if space is available. (*Zeitschrift des Vereines deutscher Ingenieure*, vol. 65, no. 5, Jan. 29, 1921, pp. 116–122, 23 figs., *et.A*)

RAILWAY ENGINEERING (See Machine Shop)

SHIPBUILDING (See also Machine Shop)

Reaction Propulsion of Ships—The Hotchkiss System

HYDRAULIC PROPULSION OF SHIPS. Hydraulic or reaction propulsion of vessels, whether air or water craft, is an old idea and has been tried many times, though thus far never successfully.

Reaction propulsion has certain advantages, the first being the relative simplicity of the propulsive equipment and elimination of the propellor with its appendages, which means not only fewer parts but absence of a rapidly rotating element outside of the ship hull subject to fouling and breakage. The elimination of the propeller leads also to the reduction of vibration. To this is added the ease with which the motion of a hydraulically propelled boat may be reversed simply by deflecting the stream forward without even reversing the prime mover. This adds to the ease with which the vessel can be maneuvered and makes it possible to eliminate the rudder, another element outside of the ship hull subject to all kinds of untoward accidents.

Finally, the thrust developed by the discharge of the stream of water is independent of the depth at which the stream is discharged, while the depth of immersion of a screw propeller greatly affects the thrust. From these considerations it follows that racing cannot occur in a hydraulically propelled boat. In addition, the depth of water in which the ship operates efficiently is limited solely by the draft of the hull and not by the draft required for the efficient working of the propeller.

Among the disadvantages cited against hydraulic propellers the chief is lack of efficiency. Various causes have contributed to the lack of efficiency shown by the systems tried in the past. If we regard hydraulic propulsion as consisting simply of the use of an internal propeller, it is obvious in the first place that loss will occur

by virtue of the fact that the stream of water has to be brought to and discharged from the propeller through pipes and passages or orifices of some description. The frictional losses in such passages have no counterpart in the external propeller, for in this case the water is drawn from and discharged into the immediately surrounding fluid. Again, in reaching and leaving the internal propeller, the water may in its flow be called upon to change its direction of movement to a considerable extent, with a consequent considerable loss of energy. The water passages, too, may change in cross-sectional area, and as a result loss will arise by the conversion of pressure into velocity and velocity into pressure.

Lately, however, several reaction propulsion systems have been tried out. The Mélot system as applied to aircraft was described in MECHANICAL ENGINEERING, April 1920, p. 234. The Hotchkiss and the Gill systems have recently been tried out for water craft.

The Hotchkiss system was tried on a weldless steel launch measuring 24 ft. in length overall and 6 ft. 3 in. in beam, with a draft of 1 ft. 5 in. on a displacement of two tons. The machinery propelling the vessel consisted of an 8-b.hp. motor coupled through reduction bevel gearing to two Hotchkiss pumps.

The general principle of the Hotchkiss system is illustrated in the diagram of one of the pumps given in Fig. 18. The pump consists of a four-bladed impeller rotating within a cylindrical casing, in which are formed three openings, namely, one in the lower half of each vertical side, and one in the lower portion of the periphery. In the diagram the two strips of the casing separating these three holes are represented as having been cut out, so that the holes really form but one hole. It will be convenient, however, to regard them as being in three. The casing is considerably wider than the impeller blades, so that between the edges of the blades and the vertical walls of the casing there is a passage on each side of considerable area.

In the diagram the movement of the boat is supposed to be toward the left. The impeller is driven in the direction of the arrow shown against it, and creates a vortex inside the casing. The water is drawn into the casing in two streams through the two side holes. Inside the casing these two streams converge, and finally become one, which, passing centrally between the two entering branches,

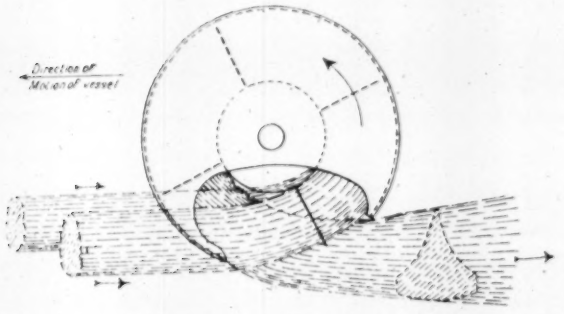


FIG. 18 DIAGRAM OF THE HOTCHKISS PUMP USED FOR REACTION PROPULSION OF SHIPS

is discharged sternward. The peculiar section which, according to Mr. Hotchkiss, the discharge stream assumes will be noted. It enables the discharge stream to pass between the entering streams without touching them, while at the same time it fills up nearly all the vacant space between them, on the assumption that the entering streams are circular or oval in section.

The essential feature of the Hotchkiss system is thus the creation of a vortex that travels along with the vessel. The water is drawn directly into the vortex without the intermediation of pipes or conduits of any description, and, therefore, frictional losses are practically avoided. The relative momentum of the incoming water, it is claimed, is not lost, but forms part of the momentum of the discharge stream.

The system is still in the experimental stages and no reliable data as to efficiency are available. It is stated, however, that the boat developed 5.6 knots (9.46 ft. per sec.) with the engine running at 950 revolutions and developing $7\frac{3}{4}$ b.hp. The speed of discharge of the stream from the pumps is calculated by Mr. Hotchkiss to be 16.4 ft. per sec. Calling these two speeds v and V, respectively, the slip is $(V - v)/V$, or 42.3 per cent. The jet efficiency, in accordance with the usual formula, is $2v/(V + v)$, or 73 per cent. Mr. Hotchkiss takes the efficiency of the pumps at 90 per cent, so that the propulsive efficiency comes out at 65.7 per cent. Taking the efficiency of the engine at 75 per cent, the overall efficiency is thus 49.3 per cent. Such an efficiency, it is stated, would not be considered bad in a similar vessel propelled by screw.

These figures, however, have not been checked by any reliable outside authority and are cited merely because of the revival of interest in reaction propulsion. (*The Engineer*, vol. 131, no. 3398, Feb. 11, 1921, pp. 140–142, 3 figs., *d*)

SPECIAL MACHINERY

Novel Rotor-Balancing Machine

THE MARTIN ROTOR-BALANCING MACHINE. Description of a simple device for balancing rotary bodies—of particular interest because of its great sensitiveness. This latter is such that, for example, when balancing a rotor of 10,000 kg., a variation of 1 kg-cm. can be easily discovered by sliding a weight of 1 kg. along the beam. This corresponds to a deviation of the center of gravity of the rotor in a horizontal direction off the axis of 0.005 mm., or approximately one fifty-thousandth of an inch.

The same result is expressed in a different way, as follows: When balancing a 10-ton Zoelly rotor of 6 ft. diameter, an overweight of as little as 10 grams (one-third ounce) on its circumference, or one-millionth part of the rotor's weight, can be readily detected.

Furthermore, the apparatus indicates the correct plane in which this overweight lies and in which its moment acts. These results

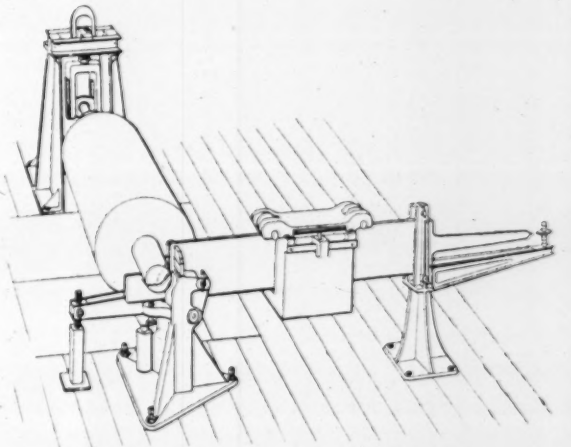


FIG. 19 MARTIN ROTOR-BALANCING MACHINE

are obtained without rotation, as it is merely necessary to turn the body to six or eight fixed positions and when actually balancing no rotation takes place. Because of this the method is not affected by the inertia of the body and the angle of lag cannot affect the results.

The machine (Fig. 19) consists of two main portions arranged to support the shaft of the rotor to be balanced. At one end the shaft is hung in a universally jointed stirrup and at the other in a bearing which is mounted on the short arm of a steelyard lever.

Having placed the rotor to be balanced in the bearings, the main weight of the steelyard is adjusted so as to bring the arm into equilibrium. The rotor is then turned a few degrees and the arm again adjusted by moving the jockey weight, this adjustment being recorded. The rotor is then turned through another section, and the necessary adjustment again made by means of the jockey weight, and so the process is continued for a complete revolution. The results are plotted to a horizontal base, and the sine curve obtained shows a maximum and minimum which indicate the points at which the center of gravity is farthest from, and nearest to, the supporting point of the balance. By multiplying the jockey weight by its displacement, a moment is derived from which the eccentricity of the center of gravity and the necessary correc-

tion are obtained. Table 4 gives some actual results that have been obtained with a large balance.

On all built-up turbines, such as the Zoelly and Curtis types, first the shaft and then each disk put on is successively balanced; the final balance obtained will then be without any disturbing couple, and many times more accurate than any result obtainable by other methods. In a drum-type turbine, such as the Parsons rotor, the overweight is taken out partly at each end in relation to the position of the center of gravity, the sum of this moment being equal to the total moment of overweight. Reduction-gear wheels can also be balanced by this machine, and for bodies which are of relatively large radial and small axial dimensions, a mandrel

TABLE 4 RESULTS OBTAINED WITH A LARGE-SIZE MARTIN ROTOR-BALANCING MACHINE

Turbine rotors balanced:	Weight, kg.	Out-of-balance moment found, kg-cm.	Weight removed (dependent on the radius), kg.	Corresponding correction of rotor's c. of g., mm.
High-pressure rotor	2678	3.75	0.208	0.014
Low-pressure rotor	5370	5.8	0.23	0.0108
High-pressure rotor	6792	36	1.35	0.053
Low-pressure rotor	9103	13.2	0.244	0.0145
High-pressure rotor	6781	21.7	0.8	0.032
Low-pressure rotor	9216	34.1	0.695	0.037
High-pressure rotor	7200	10.8	1.391	0.015
Low-pressure rotor	9203	58.9	1.1	0.064

(in itself balanced) to take such parts can be used on the machine. The machine could also be used for standardizing rotary parts. (*The Electrical Review*, vol. 88, no. 2253, Jan. 28, 1921, pp. 101–102, 4 figs., *d*)

STEAM ENGINEERING (See Power Plants)

TESTS (See Engineering Materials)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

Professional Engineering Service Announcements

One hundred and twenty engineers and engineering concerns are now represented in the Professional Engineering Service Section of MECHANICAL ENGINEERING (see pp. 106–112 of Advertising Section). This is a substantial increase over the number in the March issue, and fifty per cent more than in February. Since the addition of a classified index to this section its usefulness to those in need of specialized engineering assistance has greatly increased; and users of cards are benefited accordingly.

The classified index comprises approximately 150 headings, under which the users of professional cards are listed according to the lines in which they specialize. The card announcements appear on pages directly following, so that after a reader has selected one or more names from the classified index, he can easily find the corresponding cards giving more detailed information regarding the services offered.

With the increase in size and completeness of the Professional Service Section it becomes more and more a clearing house for engineering service by experienced engineers who have specialized in different fields of activity.

A new alloy patented in France and adapted specially to the manufacture of valves for internal-combustion engines, is composed of nickel, about 67 per cent; iron, 1 to 5 per cent; and copper, 28 to 32 per cent. It is said to have the same coefficient of expansion as cast iron, to offer great resistance to the destructive action of the high temperatures to which the valves are subjected, and to be insensible to corrosion by the hot combustion gases.

LOCOMOTIVES AND LOCOMOTIVE TERMINALS

(*Continued from page 258*)

The trend in locomotive-terminal development is undoubtedly toward facilities for executing a greater and increasing variety of heavy repairs. In fact it is not beyond the range of possibilities to comprehend a development in locomotive terminals that will supersede many of the functions now belonging to the central erecting shop.

B. P. PHELPS[1]. One of the first considerations of a new terminal should be that of ground enough to permit an expansion of each unit at least 100 per cent over the original installations. Terminals in cities should be located out far enough from the region of expensive real estate to secure enough land at a reasonable price to allow for such a ratio of expansion; unless there are peculiar operating conditions which prevent. In a developing country, the demand on terminal facilities is doubled in a period of ten to fifteen years. Therefore such layouts as shown by the author,[2] while conveniently arranged for the present needs, may soon be outgrown.

As a further provision for expansion, when the initial installation of a roundhouse includes less than a complete circle, no permanent buildings or tracks should be placed within the circle to be in the way of completing the roundhouse.

The writer would suggest that in general the storehouse should be next to the roundhouse and centrally located with reference to the machine shop, blacksmith shop, and car department. Efficient means should be provided for handling stores from cars to platform and building and also to the several shops.

The back shop (locomotive repair shop) is most convenient if located at the back of the roundhouse and about the center of the circumference of the outer wall. It would appear that a back shop located as in Fig. 1[2] would be inconvenient for machinists working on locomotives to get machine work done, especially men in the north roundhouse.

The blacksmith shop should be handy to both the roundhouse and back shop as the work done in this shop is about equally divided between running or roundhouse repairs and back-shop repairs.

On Western railroads running through districts of bad water, flue-repairing facilities demand much consideration.

In one paragraph Mr. Rink mentions the use of blow-off water from locomotives for filling boilers. Numerous tests made in bad water districts have shown that blow-off water contains one hundred and fifty to five hundred grains of soluble salts per gallon or the equivalent of about a barrel of salt to a locomotive boiler full of water. These salts do not settle but remain in solution at ordinary temperatures. Concentration of these salts in a boiler will cause the water to "prime" or "foam," which is objectionable. Except in emergency cases it is far preferable to fill boilers with fresh water.

G. W. RINK, in his closure, spoke of the chart mentioned in the discussion by Wm. Elmer, on which was recorded the frequency with which a locomotive found its way into the shop and which indicated when a locomotive was ready to go back to the main shop for general repairs. This, he said, brought out the fact that most main shops were inadequate and that they could not keep up with the necessary repairs. Therefore he thought the roundhouses ought to be helped as much as possible by providing them with as many facilities as could be afforded.

He said that he preferred jib to overhead cranes for roundhouses as the overhead crane was not capable of serving several gangs of men working on different jobs.

He pointed out that the loss of time in getting a locomotive into and out of a roundhouse was responsible for many makeshift repairs, as not enough time remained if the motive power were being used intensively. The train and engine must go whether the repair is made or not, unless the case is serious enough to warrant taking the locomotive out of service.

---

[1] Engineer of Shop Extensions, Santa Fe System, Topeka, Kan.

[2] MECHANICAL ENGINEERING, January 1921, pp. 13 and 14.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A.S.M.E.

Research Résumé of the Month

A—Research Results

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a résumé of research results with formulas or curves where such may be readily given, and to report results of non-extensive researches which in the opinion of the investigators do not warrant a paper.

Apparatus and Instruments A3–21. Viscosimeter. Use of MacMichael Viscosimeter in petroleum products is the subject of Report 2201 of the Bureau of Mines, by W. H. Herschel and E. W. Dean. The MacMichael viscosimeter is of a torsional form and has been described by W. H. Herschel in the *Journal of Industrial and Engineering Chemistry*, vol. 12, 1920, pp. 282–286. It takes a shorter time for a determination than the Saybolt viscosimeter and gives moderately accurate results with oils that are not perfectly homogeneous. The instrument requires careful attention to manipulate it. This viscosimeter consists of a rotary oil cup which is motor-driven and a torsional pendulum suspended above the cup by a piano wire. The pendulum consists of a tube enclosing the suspension wire and carrying a disk at its lower end. The deflection of the suspension is converted into absolute viscosity. The report gives the relation between kinematic viscosities and Saybolt viscosities, as well as the method of translating readings of the MacMichael viscosimeter into absolute viscosities. Bureau of Mines, Washington, D. C. Address Director.

Cement and Other Building Materials A5–21. Repeated Stresses in Concrete Beams. The Bureau of Standards has just issued Technologic Paper 182 which is for sale by the Superintendent of Documents, Washington, D. C., at 15 cents per copy. It describes the results of tests made on concrete beams 4 in. by 6 in. in cross-section, using a span of 8 ft. The beams were reinforced both top and bottom. The load was applied at two points each 6 in. from the center of the span, and at the rate of 17 cycles per minute, each cycle including an upward and downward application of load. By means of a system of levers a dead weight used for load was multiplied ten times at the beam. The loading mechanism was driven through a walking beam. Four beams were tested to failure and a fifth beam was loaded through two million cycles, although the beam did not appear to approach failure.

The four beams on which the tests were completed failed by tension in the steel. The beam showing the highest stress withstood the smallest number of repetitions. The largest number of repetitions was so small that failure in the steel would not have been expected as the observed stresses were low. Other factors than the intensity of the tensile and compressive stresses must have caused the early tension failure.

All tension failures in reinforcing bars occurred at sections where large cracks extended entirely across the section of the beam. It is possible that in some cases the bending at these cracks was sufficient to make the bending of the bar an important factor in causing failure. The slipping of the bars and the resulting opening of the cracks must have increased this action. The quality of steel used in the reinforcement was poor, although this does not account for the small number of repetitions. After 7000 cycles the slip in the end of the bar in one beam was less than 0.001 in. This is less than the amount taken as the criterion for safe conditions of bond. After 400,000 cycles the slip in the bar was so great that failure by slipping seemed imminent. This investigation was undertaken for the Emergency Fleet Corporation in connection with the development of concrete ships. Bureau of Standards, Washington, D. C. Address Director.

Cement and Other Building Materials A6–21. Tannic Acid in Concrete. The effect of tannic acid on the strength of concrete is the subject of Bulletin No. 7, by Prof. Duff A. Abrams, of the Structural Materials Research Laboratory, Lewis Institute. The Bulletin is a result of four years' investigation to determine the effect of organic impurities in sands. Natural sands could not be used for a quantitative analysis and so aggregates were prepared in which known quantities of organic impurities were present by the addition of tannic acid. The amount of tannic acid varied up to 0.40 per cent of the aggregate by weight. Compression tests were made on 3-in. by 6-in. concrete cylinders with various mixes ranging from 1 : 5 to 1 : 2. The size of the aggregate varied from a fine sand to ¾ in. Tests were made at ages of 7 days, 28 days, 3 months, 1 year and 2 years, the series including 2000 tests. The following conclusions were derived:

The results were comparable with the effects produced with natural sands containing organic matter.

All percentages of tannic acid in all mixes and ages reduced the strength of the concrete.

Less than 0.1 per cent of tannic acid reduced the strength of the concrete to one-half its normal value.

The lean mixtures are more affected than rich mixtures.

Mixtures from finer aggregates are less affected than those from coarser aggregates.

The reduction in the strength of concrete is a function of the concentration of the tannic acid in the mixing water.

Wetter consistencies are less affected than drier consistencies.

The strength falls off rapidly for small percentages of tannic acid at the beginning of the increase and less rapidly as higher percentages are reached.

The 7- and 28-day strengths are reduced by a greater amount by tannic acid than the strengths at ages of 1 and 2 years.

Some 1 : 5 mixes disintegrated before the time of test.

When higher percentages of tannic acid were used with finer sands 1 : 7 mixes were destroyed in removing them from the mold.

Care should be taken to remove surface loam from concrete sands.

Loam can be generally removed by washing.

Address Prof. Duff A. Abrams, Lewis Institute, Chicago, Ill.

Chemistry, Mineralogical and Geological A1–21. Potash Production. See *T. Poole Maynard E1–21.*

Fuels, Gas, Tar and Coke A5–21. Stenches for Determining Leakage. Technical Paper 267, by S. H. Katz and V. C. Allison, on Stenches for Detecting Leakage of Blue Gas and Natural Gas, has recently appeared from the Bureau of Mines. The report contains a number of tables, two illustrations and extends over 22 pages. It deals with the properties, intensities, quantities and cost of production of stenches and describes the method of impregnation. Bureau of Mines, Washington, D. C. Address Director.

Fuels, Gas, Tar and Coke A6–21. Sulphur Distribution in Carbonization. A study made by Prof. C. C. Thomas and U. O. Hutton, of Johns Hopkins University, Baltimore, Md., in collaboration with the Bureau of Mines was intended to determine the distribution of sulphur in carbonization of coal in gas retorts. The experiments were of three classes: first, to determine the sulphur production in gas with uniform charges of 300 lb. at different temperatures, a second set to study the effect of varying the size of the charge, and a third set to determine the effect of spraying the coal with milk of lime before charging. The article describing this research is given in the *Gas Age* for Feb. 10, 1921, and gives curves showing the rate of gas production, the effect of temperature on sulphureted hydrogen and sulphur variation, the variation of organic sulphur with the charge, the variation of carbon disulphide and organic sulphur, the effect of carbon disulphide, the effect of spraying the coal with lime, the effect of the size of the charge and the variation of the sulphur. The experiments show that the sulphur in the gas may be reduced by low temperatures, the use of larger charges, and the spraying of milk of lime over the coal.

Mechanics, General A1–21. Repeated Stresses in Concrete Beams. See *Cement and Other Building Materials A5–21.*

Metallurgy and Metallography A9–21. Metal Arc Welds. See *Welding A1–21.*

Petroleum, Asphalt and Wood Products A2–21. Properties of Crude Oils. The Bureau of Mines has issued report No. 2202 on the Properties of Typical Crude Oils from the Eastern Producing Field of the United States, by E. W. Dean. Bureau of Mines, Washington, D. C. Address Director.

Petroleum, Asphalt and Wood Products A3–21. Lighter Hydrocarbons. The Bureau of Mines has recently issued Bulletin 162, by J. N. Wadsworth, on the Removal of Lighter Hydrocarbons from Petroleum by Continuous Distillation. This bulletin contains drawings and detailed descriptions of apparatus and equipment. In addition its 162 pages comprise 31 tables showing various data from the plants, and 49 plates of drawings of apparatus and 45 figures. Bureau of Mines, Washington, D. C. Address Director.

Properties of Engineering Materials A1–21. Repeated Stresses in Concrete Beams. See *Cement and Other Building Materials A5–21.*

Properties of Engineering Materials A2–21. Standard Samples. Standard samples of materials of known composition are issued by the Bureau of Standards at different prices. A new standard cast bronze has been placed in stock and renewals of certain cast irons, bessemer steel and other materials have been added. Bureau of Standards, Washington, D. C. Address Director.

Welding A1–21. Arc Metal Welds. The properties of arc metals and arc welds as determined by tests form the subject of a paper printed in *Power*, Feb. 15, 1921, by O. H. Eschholz, of the Westinghouse Electric & Manufacturing Company. The paper shows the different ways in which the metal of the weld was applied and tested, including the form of specimens used and the appearance of broken specimens under

tension, compression, bending and impact. The article gives microphotographs. The investigation shows that properties of metals deposited from bare electrodes are dependent on the direction of stress relative to the direction of depositing the metal in the weld and also on the procedure during deposition. The greatest resistance occurs when the load is applied parallel to the direction of layer deposition and least when applied perpendicular to the layers. The strength of the weld in mild-steel plates was almost as great as the strength of the plate with high-carbon steel, which amounted to 70 per cent of the strength of the plate. The test showed that the strength of the weld with the same metal used for the arc pencil depends on the surfaces welded together, the weld absorbing from the parent metal certain materials which give it additional strength.

The presence of small quantities of iron oxide and nitride does not appear to greatly effect the properties of the metal when stressed by static load, although under repeated load and in impact testing these substances affect the strength. The field of bare alloy electrodes and covered electrodes shows development possibilities.

Wood Products A2–21. Smoke Making for Testing Circulation in Kilns. Technical Notes 127 of the Forest Products Laboratory gives a device for making smoke to be used for testing circulation in kilns. This can be used for testing circulation in any space. It consists of two bottles held in a frame, one filled with ammonia, the other with hydrochloric acid. Air is blown into the hydrochloric acid bottle through a tube in the cork above the level of the acid. Another bent tube leads from this cork into the open end of the ammonia bottle. This apparatus may be carried on a handle without danger of fire. Forest Products Laboratory, Madison, Wis. Address Director.

Wood Products A3–21. Strength of Wooden Boxes. Moisture content of wood greatly affects strength of the box. Within a week of manufacture a box made from green lumber is greatly reduced in strength. As the wood dries the nails lose their grip. After one year boxes from green lumber proved to be 1/6 as strong as similar boxes tested at time of manufacture. Forest Products Laboratory, Madison, Wis. Address Director.

Wood Products A4–21. Plywood. Wood has a tensile strength in the direction parallel to the grain which is 20 times higher than the strength perpendicular to the grain. The shearing strength across the grain is much greater than that parallel to the grain. Wood shrinks a greater amount across the grain than with the grain. For the above reasons plywood is used to make a stronger product for the same weight. The desire is to obtain material which has an equality of properties in two directions. It has been shown that an increase in the number of plies results in the decrease of the tensile and bending strength, parallel to the grain but increases these at right angles to the grain. Hence when the strength should be equal in two directions a great number of plies should be employed. A large number of plies increases the resistance to splitting from screws and bolts. U. S. Forest Products Laboratory, Madison, Wis. Address Director.

B—Research in Progress

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for coöperation or conference, to prevent unnecessary duplication of work and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Apparatus and Instruments B2–21. Micrometers. Micrometers for Electric Purposes. University of Pennsylvania, Department of Mechanical Engineering, Philadelphia, Pa. Address Prof. J. J. Morris.

Electric Power B1–21. Sky-Line Cables. A method for calculating sky-line cables is the subject of a bulletin in preparation by S. H. Anderson, of the Engineering Experiment Station, University of Washington, Seattle, Wash.

Electric Power B2–21. Current Suppression. Current suppression by means of parallel resonance is the subject of a bulletin in preparation by H. G. Cordes, of the Engineering Experiment Station, University of Washington, Seattle, Wash.

Foundry Equipment, Materials and Processes B1–21. Facing Sands. Experiments on Facing Sands for Molds to Reduce Chill and Eliminate Searching Influence of the Metal. University of Pennsylvania, Department of Mechanical Engineering, Philadelphia, Pa. Address Prof. J. J. Morris.

Heat B1–21. Heat Transfer. A study is being made by Mr. Christian Gierloff of Trondhjem, Norway, on the heat losses through building materials similar to the work which is being done at the University of Saskatchewan by the construction of small cubic houses of different wall construction which are heated by electric means.

Hydraulics B1–21. Hydraulic Formulas. The rationalizing of hydraulic formulas is the subject of a bulletin by C. W. Harris, of the Engineering Experiment Station, University of Washington, Seattle, Wash.

Machine Design B1–21. Victrola Device. Repeating Device for Victrola Records. University of Pennsylvania, Department of Mechanical Engineering, Philadelphia, Pa. Address Prof. J. J. Morris.

Machine Tools B2–21. Multiple Die. Multiple Die for Thread Cutting. University of Pennsylvania, Department of Mechanical Engineering, Philadelphia, Pa. Address Prof. J. J. Morris.

Welding B1–21. Electric Welding is the subject of a bulletin in preparation by Addison G. Bissell, of the Engineering Experiment Station, University of Washington, Seattle, Wash.

Wood Products B1–21. Motor-Truck Logging is the subject of a bulletin in preparation by F. Malcolm Knapp, of the University of Washington, Seattle, Wash.

C—Research Problems

The purpose of this section of Engineering Research is to bring together persons who desire coöperation in research work or to bring together those who have problems and no equipment with those who are equipped to carry on research. It is hoped that those desiring coöperation or aid will state problems for publication in this section.

Heat C1–21. Superheated Steam on Cast Iron. See *Metallurgy and Metallography C1–21.*

Metallurgy and Metallography C1–21. Cast Iron with Superheated Steam. It is desired to obtain references and results on the subject of the action of superheated steam on cast iron. Address R. Z. Hopkins, Hudson Motor Car Company, Detroit, Mich.

D—Research Equipment

The purpose of this section of Engineering Research is to give in concise form notes regarding the equipment of laboratories for mutual information and for the purpose of informing the profession of the equipment in various laboratories so that persons desiring special investigations may know where such work may be done.

E—Research Personnel

The purpose of this section of Engineering Research is to give notes of a personal nature regarding the personnel of various laboratories, methods of procedure for commercial work or notes regarding the conduct of various laboratories.

T. Poole Maynard E1–21. L. E. Mallory, V. R. Waite and J. T. Nash are associated with Dr. T. Poole Maynard in geological and industrial engineering at Atlanta, Ga. Mr. Mallory is devoting his time to mechanical and chemical engineering, Mr. Waite to mining, Mr. Nash to civil and drainage engineering and Dr. Maynard to geology. The recent work of these gentlemen has been the investigation of methods of producing potash from Georgia potash slates. After laboratory investigations a plant was put into operation resulting in the production of 1000 tons of potash by treatment in a rotary kiln, resulting in the recovery of about 98 per cent potash and definitely establishing the commercial feasibility of this process.

Other investigations are being carried on for the application of American clays in manufacturing industries. By the application of simple technical control, uniform products can be prepared.

This group of engineers is prepared to make geological investigations and to care for mining and chemical operations and plants and to furnish advice to manufacturers.

Address T. Poole Maynard, Ph.D., Atlanta, Ga.

University of Washington E1–21. The Engineering Experiment Station of the University of Washington at Seattle, Wash. has issued to date the following 11 bulletins, which may be purchased at various prices varying from 25 cents to 80 cents on application to the Director of the Experiment Station:

1 Creosoted Wood-Stave Pipe and Its Effects upon Water
2 Ore Resources of the Northwest
3 Industrial Survey of Seattle
4 Mining and Metalliferous Mineral Resources of Washington
5 Electrometallurgical and Electrochemical Industry of Washington
6 Ornamental Concrete Lamp Posts
7 Multiplex Radio Telegraphy and Telephony
8 Voltage Wave Analysis
9 Coking Industry of the Pacific Northwest
10 Compressed Spruce Pulleys
11 Linear-Sinoidal Oscillations.

F—Bibliographies

The purpose of this section of Engineering Research is to inform the profession of bibliographies which have been prepared. In general this work is done at the expense of the Society. Extensive bibliographies require the approval of the Research Committee. All bibliographies are loaned for a period of one month only. Additional copies are available, however, for periods of two weeks to members of the A.S.M.E. or to others recommended by members of the A.S.M.E. These bibliographies are on file in the offices of the Society.

Cement and Other Building Materials F1–21. The Effect of Organic Impurities on Concrete. A bibliography of one page giving 17 references to the effect of organic impurities when mixed with concrete. Address A.S.M.E., 29 West 39th St., New York.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Department of MECHANICAL ENGINEERING are solicited. Contributions particularly welcomed are discussions of papers published in this Journal, brief articles of current interest to mechanical engineers, or suggestions from members of The American Society of Mechanical Engineers as to a better conduct of A.S.M.E. affairs.

The Engineer Not a Good Mixer

TO THE EDITOR:

The engineer's training and duties, which call for sustained mental concentration, conspire to make him seem uninteresting or out of his element when not talking shop. Except in large cities, which support engineers' clubs and similar organizations, he finds himself more or less out of human touch even with his professional brethren. As a result of these circumstances the engineer is apt to develop a manner of reserve which not only is not wholesome but is a drag on his greater worth both to himself and to society.

How to counteract this manner and induce the spreading of a wider comradeship is a subject which may well deserve the earnest consideration of our organization. Anything that facilitates the spirit of fellowship and better understanding cannot fail, in the writer's estimation, to stimulate progressive thought and action in our ranks.

OTTO H. L. WERNICKE.

Gull Point, Fla.

The Position of the Engineer in Industry

TO THE EDITOR:

Such addresses as those delivered recently to engineers by Mr. Hoover, Major Miller, and Mr. Gompers, have brought out clearly the fact that the position of the engineer in industry has really become a unique one. While enjoying the confidence of the owner of industry he has overcome some of the prejudices and gained the approval of organized labor. This recognition of the growing place of the engineer in industry by both the owner and the worker not only opens a wider field for him, but involves also a twofold responsibility.

Now that we are surrounded by changed conditions in the business world and with a definite reaction setting in against organized labor, how much of a modification will be found in the attitude of the engineering profession, and will the newly acquired responsibility fade into the background? Obviously the changed attitude of labor, prompted largely by the fear of discharge, while enabling the owner to obtain a greater per capita output and more favorable concessions, contains little of constructive value to the furtherance of real coöperation. Will not the times directly ahead of us offer fewer inducements and greater difficulties for these efforts to create a basis for real understanding?

The writer recalls about ten years ago when the efforts of the engineer to introduce scientific management into the industries were coming to the attention of the general public, that certain machinists' trade unions caused a cartoon to be circulated which was intended to arouse the worker against the efficiency movement in shops. The central figure in the picture was an extremely busy machine operator who frantically and literally spread himself between two machines. He was flanked on each side by an inquisitive time-study artist, while in large letters referring to the seat of his reasoning powers was the caption "solid ivory." While this same view may yet be had generally by workers, there is nevertheless ample evidence that the engineer's efforts have convinced many of the labor leaders of their value. But now with conditions tightening up there are many instances of cuts in the worker's earnings without due regard to the smaller drop in living costs. These circumstances are quite likely to cause the worker to feel that somehow the efforts of the engineer have made it possible for the employer to get more out of him and at a lower cost.

On the other hand, the employer has recently given evidence of opposition to the engineer's attempts in the cause of harmony. The recent attack upon Mr. Hoover by a Chicago manufacturer's paper, condemning his conference with labor leaders, is a case in point. An article in the current number of a prominent industrial magazine shows one instance of the lack of appreciation of the efforts made to create shop councils and give employees a means of representation. These are clearly indications of what may be expected if the present industrial condition continues.

No one who is at all familiar with the facts can doubt the beneficial effects of the engineer in industry during the period of maximum demand just passed. But now with demand at a minimum, is the resulting clamor from both sides to deprive the engineer of the advantages already gained which would aid him in increasing the "field of common interest" referred to by Mr. Hoover? Surely it is possible to determine a definite attitude toward such matters as shop councils, employee education and representation and collective bargaining, all of which have a vital relaton to the establishment of a basis of understanding. Will it be frankness or secrecy, enlightenment or ignorance, mutual interest or suspicion and distrust, which will dominate our industries? On the outspoken opinion of the engineering profession and the attitude with which this question is met, much will depend.

It is of course recognized that there are many things to be settled in the proper development of rational industrial relations, but the basic facts can be recognized and adhered to, in spite of the reaction felt and expressed in many quarters. The training of the engineer and his habit of thought in basing judgment on facts and figures can be best put to use now when the extremists on both sides are attempting to undo a work of real constructive value. As one writer has expressed it, "They who have a big message for an anxious nation are the engineers and production experts, who are able to see that industry has a human as well as a material side."

GILBERT R. HAIGH.

Lansing, Mich.

Endorses Idea of Engineers' Official Directory

TO THE EDITOR:

I am of the opinion that an official biographical directory of the members of the four national engineering societies would supply a real need. I have often had to obtain information regarding the professional careers of various engineers with whom I was not personally acquainted, and have had much trouble and inconvenience in obtaining it. It occurs to me that some such publication as you suggest on page 30 of MECHANICAL ENGINEERING for March, prepared by the societies themselves, working in coöperation, might replace their year books once every five or ten years.

The last edition of Who's Who in America contains 23,000 names and is sold to subscribers for $6.50. Making allowance for duplicates, I suppose there would be less than 50,000 names in a Who's Who Among Engineers. With the edition twice as large as that for Who's Who in America, the total price, it seems to me, should not exceed $10, and might be materially less.

The societies already have a large amount of the necessary biographical information and competent editorial staffs to prepare it. If the matter is begun now, probably the first edition could not be issued before 1925. I should think that in that same year these societies could omit issuing their annual year books, the saving from which could be applied to this new publication. There would undoubtedly be a large sale from such a volume to libraries, advertisers and commercial interests.

I sincerely hope the project can be carried through, not only for the convenience to the members of the engineering profession, but also for the legitimate publicity that it would bring to the general public regarding the work and lives of engineers.

S. M. Woodward.

Iowa City, Iowa.

The Monotony of Repetitive Production Methods

To the Editor:

I do not believe that Dr. Moss's comment in the March issue of Mechanical Engineering on the monotony of repetitive production methods is quite comprehensive enough. There are unquestionably operators, men who are past middle life, who welcome the monotony of repetitive work on account of the fact that they are sure they can perform these accustomed duties satisfactorily, and also on account of the tendency to resist any sort of change that is found among older men. Any shop foreman has had numbers of instances of this sort in his experience—men who have done one thing so long that, if put on something no harder but new, they go to pieces on the strange work. Lack of self-confidence holds many men of all ages and degrees of mentality to those things that they are sure of. It is not that they do not like variety, but they are afraid of it.

There is another type of men both young and old who are found to resist change. In this group might be included the heavy, unimaginative types, the nerveless, stolid immigrants, the Man-with-the-Hoe types, and the youths who frequently make good operatives but are incapable of further advancement. The fact of the matter is that under present production methods this type of man is entirely acceptable to employers. They are not uneasy or dissatisfied unless stirred up by some one whose business it is to do it. An ambitious, active-minded man if held down to monotonous work either gets out of it as soon as possible or frets over it, which means a dissatisfied workman, and this may mean all kinds of trouble.

If Dr. Moss desires to secure evidence of the fact that there are certain types of men who do not prefer monotony of work, let him go into the toolroom of his shop and ask each of the toolmakers—die sinkers excepted—if he would rather run a nut-tapping machine or a semi-automatic screw slotter at the same pay as he is receiving as a toolmaker. And I may be doing the die sinkers an injustice at that.

L. L. Thwing.

Columbus, Ohio.

Development of Power from Wave Action

To the Editor:

During the summer of 1919 while residing at Oswego, N. Y., the writer made frequent trips along the southern shore of Lake Ontario, where in many places the outcropping rock forms a series of ledges or shelves against which there is often rather vigorous wave action.

In favorable locations the water, after striking these rocks, would be thrown fifteen to twenty feet in the air. After watching this display on several occasions the writer conceived the idea that if the waves were allowed to enter a funnel-shaped vessel and brought to rest therein, a considerable pressure might be developed at the smaller end; and that this pressure, if means were afforded, might be used to discharge water against a considerable static head. At the particular point investigated the farm land extended down to the water's edge so that excellent use could be made of the water for irrigation. The idea in that case seemed such a practical one that a crude funnel was constructed out of some old sheet iron and anchored with stones. This gave surprisingly good results and seemed to indicate that a more elaborate structure might be justified. To make the scheme more practical, a check valve might be added in the pipe leading from the small end of the funnel and an elevated storage tank provided to receive the water if required. It was planned to construct an experimental wave pump and place it in operation the following summer, but in the meantime the writer moved from Oswego and the matter was dropped.

It was estimated that in two or three days out of each week sufficient wave action was developed to operate the pump, while it often went several weeks without rain. The writer has already considered the possibility of using such a pump to elevate a large quantity of water to a height of four or five feet and allowing this water to flow through a small hydraulic ram and lift a portion of itself to a height of 50 or 60 feet or possibly more. Its limited times of operation might be a serious disadvantage, but on the other hand it might be entirely practical in some cases. It would certainly be an interesting and inexpensive arrangement and the writer hopes that this account may be the means of encouraging some one to undertake the construction of such a wave pump.

Allen F. Sherzer.

Ann Arbor, Mich.

Calibration of Nozzles for the Measurement of Air Flowing into a Vacuum

To the Editor:

The tests summarized in Wm. L. De Baufre's paper on the Calibration of Nozzles for the Measurement of Air Flowing into a Vacuum, which appeared in the November issue of Mechanical Engineering, page 607, appear to the writer to be the most accurate air measurements ever made. He was surprised, however, after reading the description of the theory and elaborate care taken with the tests, to find such great variations in the "average percentage weight-flow efficiencies" as those given in Column 6 of Table 2. This great variation disappears if the "coefficient of discharge" instead of the "weight-flow efficiency" is worked out.

Applying the formula[1] $\Omega = 0.001042\ Q/d^2$, where Ω = coefficient of discharge, Q = capacity of the nozzle in lb. per hr. and d = diameter of the nozzle in inches, to the fourth column of Table 1, the following values are obtained for the coefficient of discharge for the 20 nozzles:

Nozzle	Values	Nozzle	Values	Nozzle	Values
1	0.971	8	0.9715	15	0.9712
2	0.971	9	0.9722	16	0.9712
3	0.972	10	0.971	17	0.891
4	0.9725	11	0.971	18	0.972
5	0.971	12	0.9715	19	0.971
6	0.9715	13	0.9715	20	0.9715
7	0.9725	14	0.9715		

The amazing consistency of these values, except in the case of nozzle No. 17, shows the excellence of Mr. De Baufre's experimental work.

John Hodgson.

Leighton Buzzard, England.

Requirements of an Industrial Appraisal

To the Editor:

We have read with interest Mr. James A. Brown's letter on Appraisal Principles Applied to Industrial Properties, which appeared in the March issue of Mechanical Engineering.

During a lengthy experience as industrial engineers and accountants we have often been shown appraisals, supposedly to assist us in our work. Without being unduly critical, we must confess we have been struck by the variety of opinions among appraisal engineers as to the values to be presented and the manner of presentation. Certainly, they cannot all be right. There must be one best form for maximum applied usefulness. Let us see if we can find it. (We speak particularly of industrial appraisals, having no intention at present of contributing to the controversies raging about the evaluation of public utilities.)

Mr. Brown states very succinctly eleven principal uses of appraisals, whether industrial or public utility, including: (1) Rate setting, (2) depreciation charges, (3) taxes, (4) insurance, and (5) financial arrangements. Let us add one more: (6) Burden distribution for manufacturing-cost determination.

Passing by, for the present, special appraisals for sale, stock issue, loans, etc., it may be interesting to many readers of Mechanical Engineering for us to recapitulate briefly the requirements which, according to our observation, an industrial appraisal should meet.

[1] Derived from Eq. 27 of Hodgson's paper on the Commercial Metering of Air, Gas and Steam, Proc. Inst. C. E., vol. cciv, part 2.

We have found that the chief need in most plants is for an appraisal which will tell the operator just where he is at: i.e., a descriptive detailing of each piece of real property and equipment, with its *origin, date, original cost in place, rate of depreciation and present condition*. The appraisal schedules should present all these, so that each item may later be transcribed on a card, thus initiating a flexible and permanent equipment record. A schedule should include only one class of equipment, as buildings, machines, shafting, etc., much as such items would be classified in the ledger accounts. A total replacement value for each schedule should be given. Moreover, each schedule should be paragraphed and subtotaled by manufacturing departments, buildings and floors.

Total values should be summarized in three ways: by schedules (or ledger accounts), by departments (building space being prorated among these) and by insurable and non-insurable values. The first two, of course, present invested capital; the last, replacement values.

Unless equipment is already numbered, a system of identifying numbers should be used and key drawings made, linking the items listed in the schedules with their location in the plant.

Now, an appraisal so detailed and so arranged, with all values based primarily upon original investment, supplemented by general replacement costs, will serve all the aforementioned purposes. For it will set forth the present state of invested capital for determining net earnings; the amount of annual depreciation of each class of equipment; the insurable values; and the amount of investment in each manufacturing department.

Then, too, as a basis for financial statements, such an appraisal ould carry far greater conviction than a mere generalized estimate of operating worth.

Moreover it is economically stable, based as it is upon invested capital; as, for example, is the computation of excess profits tax by ruling of the Treasury Department; and (rightly or wrongly) of public-utilities rates by the various rate-setting bodies. Upon it may be erected any temporary superstructure demanded by shifting dollar values and the like; but in itself it is like a bank account, which reflects money paid in for years, with corresponding withdrawals. Interest is paid on the balance in dollars, whether these will buy forty cents' worth or a hundred.

MORGAN G. FARRELL.[1]

New York, N. Y.

The Latin-American Situation Regarding Weights and Measures

TO THE EDITOR:

Carrying out the policy of the Society in encouraging discussion of papers presented at its meetings, I give below certain information recently secured relating to weights and measures in use in Latin-American countries and which corroborates that in a paper given two years ago before the Society.

Persistent statements, unaccompanied by facts, have been extensively circulated throughout the United States, tending to controvert the paper in question.

Several years ago the results of an investigation of the conditions regarding weights and measures existing in Latin America were brought to the attention of the A.S.M.E. Committee on Weights and Measures. This investigation had been made in order to obtain information as to what weights and measures were being used in South American countries, as to how far compulsory metric legislation had been effective in supplanting existing systems, and as to what degree confusion had resulted from an attempt to make the change to the metric system.

The sources from which they were received, as well as the representative character of those making reply, were believed to be of such a nature as to merit giving a résumé of those facts. The questions were submitted through the National City Bank of New York, the United Fruit Company, the *American Machinist*, and W. R. Grace and Company. The replies were tabulated and presented to the A.S.M.E. at the Annual Meeting, December 1918, and are to be found in Vol. 40 of Transactions, page 773.

This investigation tended to show that after more than half a century of effort the old systems of weights and measures had not been eradicated, but instead had saddled an additional system on to what already existed, resulting not only in the expense of attempting to make the change but in augmented confusion following the attempt.

Corroboration of this has recently been received from what seem authoritative sources which it will be of interest to publish. The paper above referred to, Mr. Halsey's, was taken up for discussion by a metric advocate, who urges still further legislation to force the metric system on South America, apparently recognizing the failure of the efforts so far made in that direction, and admitting the present chaos resulting from the extensive use of other systems mixed with the metric system in those countries. The gentleman is Senor Carlos Basadre, of Lima, and his findings are published in the June 1920 issue of the *Bulletin of the Society of Engineers of Peru*. Referring to the paper, Senor Basadre says:

> Mr. Halsey's argument is manifestly powerful and based on demonstrated facts, and not merely on theoretical considerations. Without attempting to pass judgment on the advantages and disadvantages resulting from the adoption or rejection of the metric system as the single standard of weights and measures in the United States, let us consider some of the facts established by Mr. Halsey, the failure of the metric system in South America, and the idea that the old Spanish system can be brought into uniformity with the English system.....
>
> Latin-American countries adopted some time age the decimal metric system; but, with the exception of Uruguay, contented themselves with recognizing it officially without troubling themselves at all to familiarize the mass of the population with its use little by little by means of an active and constant propaganda.....
>
> It can be stated that the official intervention alone has been effective, and this in an intermittent manner at such time as the confusion caused by the use or abuse of heterogeneous weights and measures has created a pernicious situation actually alarming.
>
> What has really happened is that the metric system has become mixed, sometimes more, at other times less, with the old Spanish system, with some English measures, and with the native measures, forming a heterogeneous conglomerate, which can be classified as a third system, peculiar to each country. If this chaotic state has been able to persist up to the present time, it is precisely because in the last analysis it has been the metric system that has always intervened to resolve all the uncertainties and confusions (translated from the original.)

The metric system was made legal in Peru in 1862. In 1869 an executive decree made that system compulsory for public business, and in 1920, fifty-eight years after the law was enacted, the results are as stated by Senor Basadre.

Mr. W. Graham Clark, Special Agent of the U. S. Dept. of Commerce, after several years' investigation of countries in Latin America, names in his reports the systems of measurement in nine of those countries, which he personally visited, and in every case he confirms the findings in the A.S.M.E. paper.

Mr. A. Hyatt Verritt, in a book entitled Getting Together with Latin America, states that he lived many years in those countries and names the systems of weights and measures of eighteen of them; he, with but one exception, confirms the statements of the report.

Mr. V. L. Havens, editor of the *Ingeneria Internacional*, who has had personal experience in most of the Latin-American countries, especially in the purchase of lumber, reports that the metric system is not used to any appreciable extent in the lumber industry, the English and Spanish systems being practically universal.

In *Commerce Reports* for April 21, 1919, in a summary of the various Consular Reports in which particulars are given of the weights and measures used in seven Latin-American countries, there is again a corroboration of the statements in the A.S.M.E. paper. The complete Consular Reports on this matter are now being studied and will be the subject of a later report, but it can now be stated that they fully bear out the statements which have been made as to the difficulty of making the change and the confusion resulting.

Shortly after the beginning of the World War, Mr. O. P. Hood made an investigation of the situation in South America as regards the machine industry. Mr. Hood, who is familiar with both the Spanish and Portuguese languages, spent eighteen months in the South American countries, and as a result of his investigation reported that 39.3 per cent of the machine tools there in use are of American make, while 43.2 per cent are British, leaving a remainder of only 17.5 per cent from possible metric countries. This

[1] Director of Construction and Appraisal, Miller, Franklin, Basset & Co.

shows a preponderance of nearly 5 to 1 in favor of tools made on the inch basis in spite of the fact that Germany had during the prewar period an extremely energetic organization for selling and financing in those countries, and it is believed that German influence was largely instrumental in inducing them to enact legislation favorable to the metric system, such as would work into the hands of German interests.

As Chairman of the A.S.M.E. Committee on Weights and Measures, I would welcome any further information giving the actual facts regarding conditions affecting weights and measures in Latin America.

LUTHER D. BURLINGAME.

Providence, R. I.

Details of Diesel-Engine Clutches Used in German Submarines

TO THE EDITOR:

At the Philadelphia Navy Yard there is a large ex-German Submarine, the U-140, I believe. Last fall when the navy yard was thrown open to visitors for the benefit of the Naval Relief Association, I went aboard this vessel and was much interested in her

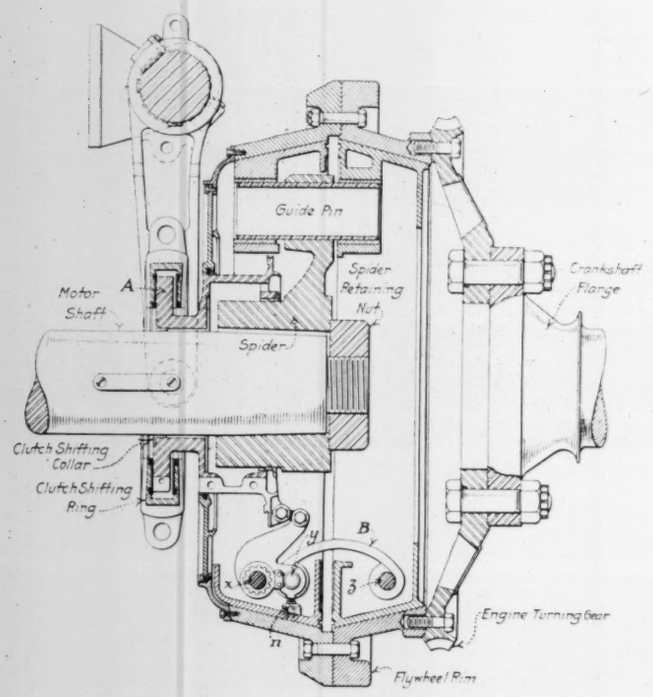


FIG. 1 SECTIONAL VIEW OF CLUTCH

machinery; but what most attracted my attention was the clutches, which were very small for such powerful engines—Diesels, eight-cylinder, 21 in. bore by approximately 28 in. stroke as nearly as I could estimate.

These clutches may possess some very desirable features which would prove of value to our industries. Has the Society any information regarding these clutches or can it be obtained? Any information upon their design will be highly appreciated.

MARMADUKE M. WILLS.

Fitchburg, Mass.

[The foregoing letter was referred to Lieut-Comdr. Mark C. Bowman, U.S.N., Washington, D. C., who has very courteously supplied the desired information, based on drawings made by the Navy Department. Shortly before the close of the war Lieutenant-Commander Bowman gave a talk on the development of submarine Diesel engines before the Washington Section of the A.S.M.E. in which he showed intimate knowledge of the many details of design and construction. His communication relative to the clutch is given below.—EDITOR.]

MAIN ENGINE CLUTCHES FOR GERMAN SUBMARINES

TO THE EDITOR:

A general inspection of surrendered German submarines has indicated that engines for these vessels were of four standard sizes. A 10-cylinder 3000-hp. engine was built for installation in large cruiser submarines. A number of these engines were found in the shops ready for installation at the time of the signing of the armistice, but only one pair was installed in a boat, the U-142, which performed no active war service. Six-cylinder 1750-hp. engines, similar in cylinder dimensions to the 3000-hp. engine, were installed in the U-135, 136, 139, 140 and 141. A large number of 1200-hp. six-cylinder engines were installed in operating submarines and gave excellent service throughout the war. A fourth size, of 530 hp., six-cylinders, was found in late types of mine-laying and coastal boats.

The clutching device for connecting the engine and motor shafts is of special interest in view of the history of such devices in general and has led to numerous inquiries as to its construction. The same type of clutch was installed with each size of engine.

The clutch is of the double-cone friction type, of semi-steel and

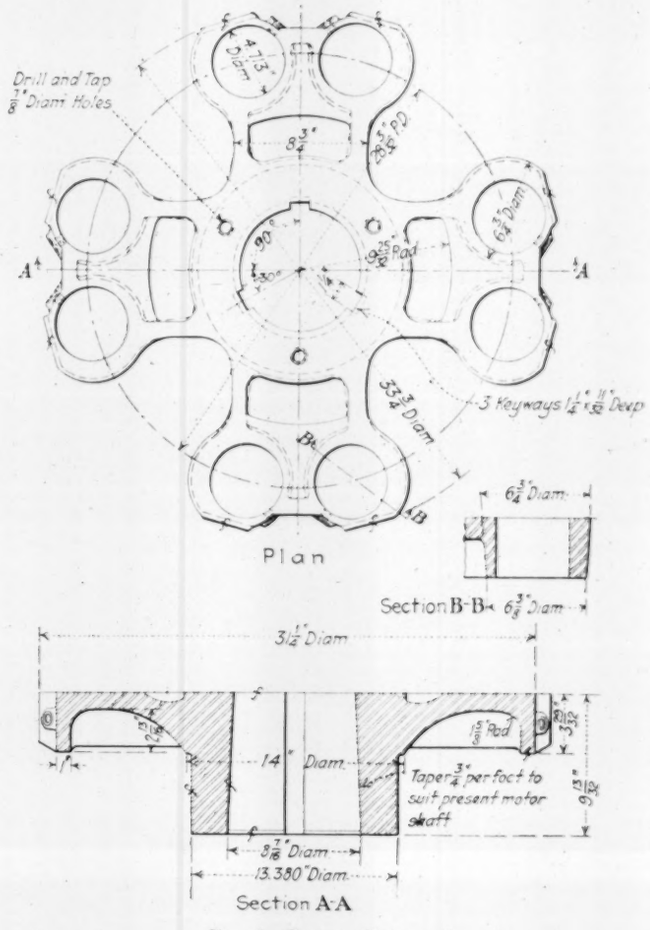


FIG. 2 CLUTCH SPIDER

cast iron, operated by air except in the 530-hp. size, which is operated by hand through worm and gear.

The outer casing or female member, which serves as the flywheel, is carried on the engine shaft. This casing, as shown in Fig. 1, is made in two parts bolted together with the inner surfaces machined to cone surfaces, the cones base to base.

The male part is attached to the motor shaft by three keys and a retaining nut, carrying a flange or spider in which are fixed eight large guide pins parallel to the shaft axis and extending through the spider on either side as shown in Fig. 1. Two inner clutch cones are carried on these guide pins, on which they here a sliding fit. They are of semi-steel and their outer or peripheral surfaces are finished to conform to the inner conical surfaces of the female or flywheel part.

In Fig. 2 are detail sketches of the spider and in Fig. 3 are details of the two male cones carried by the spider. These cones are alike except that stops are cast on the after cone (the cone nearer the motor) to limit the travel of the operating collar, as shown at *X* in Fig. 3.

The machined surfaces of the inner cones, Fig. 3, have oil grooves which insure that when unclutched or disengaged a complete film of oil will fill the clearances between the cone surfaces. The gradual squeezing out of the oil film as the surfaces are forced together enables the clutch to be thrown in when the engine is running.

The clutch is thrown in by forcing the inner cones apart until the male and female cone surfaces engage, and by drawing the cones together and thus releasing the surfaces the clutch is thrown out. The inner cones are drawn together or forced apart by a series of links and toggles actuated by a sleeve (*A* in Fig. 1) sliding on the motor shaft.

Referring to the lower half of Fig. 1, the center *x* is shown fixed to the forward cone and center *z* to the after cone. The clutch is engaged by separating centers *x* and *z* by forcing center *y* down to a line joining centers *x* and *z*. An adjusting cam around center *x* provides adjustment for wear in cones and bushings of the operating gear.

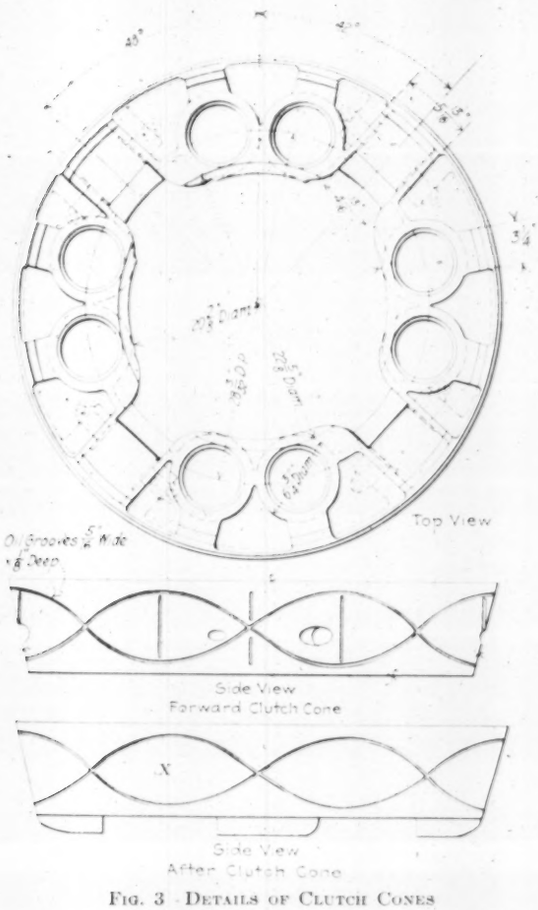


FIG. 3 DETAILS OF CLUTCH CONES

It will be noted that the forward link member *B* joining centers *y* and *z* (Fig. 1) is a steel leaf spring and that a further downward movement of center *y* against the stop *n* tends to decompress the spring slightly and to lock the mechanism. This spring is an important element in the mechanism. It is of chrome-vanadium steel with a tensile strength (annealed) of 80,000 lb. per sq. in. and an elastic limit of 50,000 lb. per sq. in. (annealed). It is heat-treated and quenched in oil.

There are four of these sets of operating links equally spaced and placed between pairs of pins in the blank spaces of the spider, Fig. 2.

Fig. 4 shows the clutch in diagram for the 1200- and 1750-hp. sizes, noting the principal dimensions, as also does the following table. No data for the 530-hp. and 3000-hp. clutches are now available.

Horse-power of engine	R.p.m.	Largest diam revolving part, in.	Cone angle, deg.	Cone diameter, in. max.	Cone diameter, in. min.	Area of friction surface, sq. in.	Crank-shaft diam., in.
1200	450	49-3/16	14	39-5/8	35-15/16	1765.112	9.453
1750	380	49-3/8	14	43-1/16	37-15/16	2608.297	11.219

The operating gear of the clutch used with the 1200-hp. engine consists of a double-acting air cylinder mounted on the floor just inboard of the clutch and connected to the ship's air line under 100 lb. pressure. The piston of the air cylinder drives a crosshead to which is attached a lever, the other end of which is keyed to a shaft supported by a fixed bracket above the clutch. The shaft leads over the clutch and drives a lever leading downward and end-

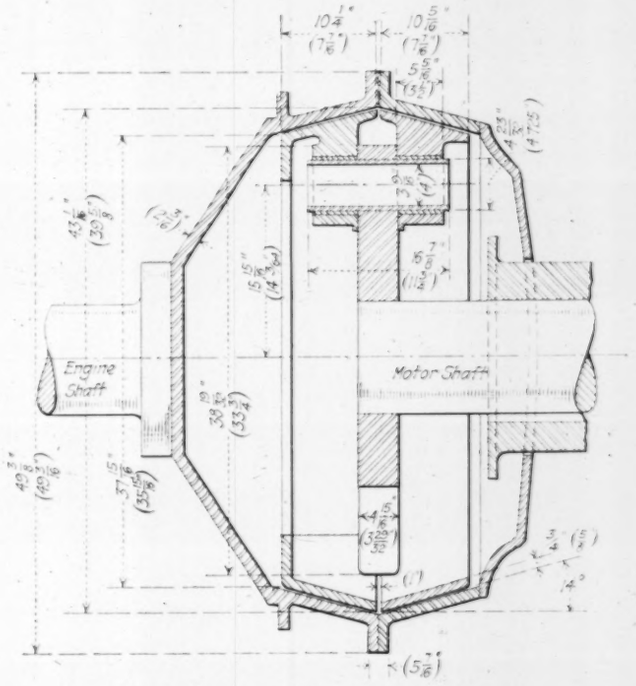


FIG. 4 PRINCIPAL DIMENSIONS OF CLUTCHES
(Dimensions in parentheses are for clutch for 1200 b.hp. at 450 r.p.m.; others for clutch for 1750 b.hp. at 380 r.p.m.)

ing in a fork end or yoke attached to a ring around the sliding collar which operates the clutch.

Assuming that the pressure of the air cylinder builds up to 100 lb. per sq. in. before the operation of clutching is complete and that maximum normal thrust in the cones is obtained when center *y* is 1 deg. above the line of centers *x* and *z* (Fig. 1), the following data are found:

Area of operating cylinder = 18.665 sq. in.
Force on crosshead = 100 × 18.665 = 1866.5 lb.
Force on operating collar through levers = 3732 lb.
Resolved force at center *y* normal to line of centers, = 1925.2 lb., which produces an axial thrust on each cone of 1925.2 tan 1° = 110,012 lb.
Normal thrust = 110,012 × sin 14° = 26,621.9 lb.
Total normal thrust per cone = 4 × 26,621.9 = 106,448 lb.
Friction area of each cone = 882 sq. in.
Unit pressure = 106,448/882 = 120.7 lb.

Referring to the engine itself,

B.hp. of engine = 1200; r.p.m. of engine = 450
K = coefficient of fluctuation of turning moment = 1.6 for 6-cyl. engine.
M = maximum turning moment of engine in in-lb. = $\frac{1200 \times 63{,}000 \times 1.6}{450}$ = 168,000 in-lb. × 1.6 = 268,800 in-lb. Assuming now that
N = total normal pressure on cones; *R* = mean cone radius
f = coefficient of friction; $N = M/fr$; $f = M/Nr$

then $f = \frac{268{,}800}{106{,}488 \times 18.89} = 0.133$ (coefficient of friction for steel on iron, freely lubricated).

M. C. BOWMAN,
Washington, D. C.

MECHANICAL ENGINEERING

A Monthly Journal Containing a Review of Progress and Attainments in Mechanical Engineering and Related Fields. The Engineering Index (of current engineering literature), together with a Summary of the Activities, Papers and Proceedings of

The American Society of Mechanical Engineers

29 West 39th Street, New York

Edwin S. Carman, *President*
William H. Wiley, *Treasurer* Calvin W. Rice, *Secretary*

PUBLICATION COMMITTEE:
George A. Orrok, *Chairman* Ralph E. Flanders
George J. Foran Alex. G. Christie
John T. Wilkin

PUBLICATION STAFF:
Lester G. French, *Editor and Manager*
Frederick Lask, *Advertising Manager*

Contributions of interest to the profession are solicited. Communications should be addressed to the Editor.

C 55 The Society as a body is not responsible for the statements of facts or opinions advanced in papers or discussions.

The Opportunity of the Engineer

Dexter S. Kimball

THE ease and promptness with which the public as a whole becomes accustomed to and takes advantage of the work of the engineer, using the term in a broad sense, is almost startling. Surprise at and fear of radical innovations in transportation and private service quickly give way to blasé indifference followed instantly by all manner of criticism that these things are not better constructed and managed.

Little outbursts of criticism should not be construed (as they are by some people) as indicating a lack of appreciation of the work of the engineer. They are an integral part of the influences that make for progress. The world in a way has always obtained as much engineering talent as it demanded. It is true that the engineer and inventor have had a tremendous influence in changing man's environment and in making this old earth comfortable and more habitable; but it is also true that these same engineers are, to a large extent, products of their own surroundings; and much of their progress has been made by supplying wants created by the public.

If the engineer has not been appreciated as much as some other classes of men, it is because his service to humanity has not been the highest. The men who render the greatest service to any nation are those who mold its *ideals*, and the philosopher and the poet will continue to wear the bays as long as they lead in this line. True, the work of the engineer has made it possible for us to realize more fully our ideals if we could only take full advantage of the productive processes which he has developed and the leisure that should result therefrom; for every day makes it clearer that highest mental and moral development rest primarily on material prosperity. It is difficult to be high-minded and hungry at the same time.

The engineer most naturally applied his scientific method first to constructive engineering and it has become second nature with him to collect data, to analyze the same and to plan work and predict results on this solid basis. But the administration of modern industry has come to require a considerable knowledge of constructive art, and the natural tendency to seek a solution of the problems of administration on the basis of accumulated knowledge rather than on an empirical basis has made an opportunity for the engineer that has carried him far afield and brought him closely in touch with the administrative side of both private and national affairs. To this new field he has quite naturally brought the analytical methods of his calling, and the art of management bids fair to be placed on a much more rational footing because of his labors in this new field of activity. *Compilation, analysis, prediction*, are the methods he is employing, and stripped of all its technical terms and high-sounding titles so-called Efficiency Engineering or Scientific Management and its correlated branches represent an effort to raise business management of all kinds from the vague empirical basis on which it now rests and place it on a scientific footing comparable with constructive processes. The progress which this movement makes will, as before noted, depend not on the effectiveness of these methods alone, but on the reactive influences which it meets with or awakens. Efficiency is not the sole criterion by which industrial phenomena are to be finally judged. Whether we will it or not, industry is being looked upon more and more as a means of supporting human existence and less as a means of creating individual or corporate dividends. The most efficient kind of factory for the creating of dividends would be equipped with the highest order of labor-saving machinery and management and operated by slaves. And as we move farther and farther away from this extreme ideal so we will become more and more critical of processes and methods of production. It is going to be a nice problem in social and political organization to reconcile the many conflicting reactions, and the full import of the movement will be more and more appreciated as our natural resources become more depleted and the struggle for existence becomes keener.

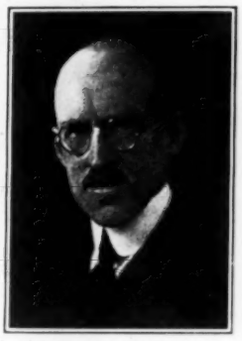
The influence of this new study on the engineer himself will be far-reaching; for he must draw his basic facts for this work not only from his own field of engineering but also from economics, accounting, psychology and other sciences which heretofore he has known little or nothing about, or has ignored. And this has brought him very close to the pivotal problem of our civilization, namely, the fair and equitable distribution of the wealth which he is so instrumental in creating. If he can master the fundamental truths that lie at the bottom of the problem or if he will have the wisdom and foresight to call to his aid the masters of thought in these lines, it is not beyond reason to hope that as he has conquered the problems of production and is now conquering the problem of administration he may evolve from his riper experiences in these fields a solution of the remaining problem which will be satisfactory to all. It is apparent that the solutions already offered fail to satisfy; but it by no means follows that these are the only possible solutions any more than the old methods of management were the only ones possible. In fact, as we look back even a few years the philosophies of engineering and manufacturing as then practiced seem very inadequate indeed; and the theories of management of yesterday are rapidly passing into obsolescence. We are sadly in need of a new type of industrial philosophy and new methods of distribution. We are in need of a new type of industrial leader; and I believe that if he comes at all in the near future he will come from the ranks of the industrial engineer, using the term in the broadest sense. It is true that other classes of men are familiar with and use the engineer's methods, but he is going to have a particularly advantageous position from which to attack this problem, for the near future will see him a dominant figure in industrial management where he will meet the problem at first hand. Here is his opportunity. It is hardly likely that any one man will be able to solve this difficult problem, and if it is solved it will probably be the work of many brains. But the man who first points out the way to a solution will not need to envy any man his glory, for posterity will surely place him in the ranks of the immortals.

I have every confidence that the engineer will rise to this opportunity and there are many signs that these ideas are stirring in the minds of forward-looking engineers. It is with no small gratification that we all see the elevation of our past-president James Hartness to the gubernatorial chair of his own state, and see Mr. Hoover, an engineer by training and experience, a member

of the cabinet of the new administration. These are pioneer workers in a field where the lawyer and the politician have long reigned supreme, and their stewardship will be watched by all engineers and others with great interest. It is an auspicious beginning that should hearten all who believe in the application of scientific methods to all problems of human existence.

DEXTER S. KIMBALL.

A Place for Non-Scientific Management



RALPH E. FLANDERS

THE problem of organizing a large machine shop is naturally solved in different ways for different conditions.

For the manufacture of a single product on a large scale—an automobile chassis, for instance—the shop is usually departmentalized according to its product, particularly where the output is great enough to permit continuous production in most of the operations. Thus there will be a department for camshafts and crankshafts, another for rear-axle bevel gears, another for transmission gears, etc.

At the other extreme, where there is a wide variety of product in varying quantities, the usual scheme has been to departmentalize the factory along the line of processes. Thus there will be a milling department, a drilling department, a grinding department, etc., common to all the various products. These are often combined with separate heavy machining and assembling departments, each devoted to a special product.

There is a third method, not often followed, which has decided advantages for the shop manufacturing a limited line in quantities which do not vary too widely. This consists in dividing up the plant into separate departments, one for each of the products and each practically complete in all of its details for the manufacture and storage of parts and for their assembly into completed machines.

At first sight such a solution seems like a backward step, but its advantages become more apparent on study and particularly after actual trial. Our modern methods of management have become absurdly complicated and topheavy, but the proposed method remedies the evil by simplifying the problem. Among other advantages it affords the following:

The entire parts manufacture for a product can be concentrated in one department, eliminating interdepartmental correspondence and friction.

A recurrent routing program can be established, free from the interruptions of other products, so that routing is standardized instead of being in a chronically unsettled state.

Machines may be placed in the general order of the operations and the whole department located beside the stock room, which in turn adjoins the assembling department. Thus trucking and the supervision of widely scattered parts are greatly simplified.

To sum up the possibilities, it may be said that the whole scheme of management may be so arranged that *reference is made to the work itself*, moving in its appropriate channels, instead of to cards or other records. These are often inaccurate and always expensive, and are usually located in some quiet spot far from the scene of action.

It is unnecessary here to go into the various arrangements required to maintain proper relations with other divisions of the work, or for taking care of the unescapable breakdowns of machines and systems. These problems are, in fact, less serious than with more complex schemes of organization.

My faith in the plan is based on my belief that a few ordinary mortals with energy and fair ability can handle separate divisions with success where the work is so arranged that it can be touched by the hand, seen by the eye, and comprehended by the brain: and that the same men will work much less effectively when handling interdependent departments, run by a system of reports and records, even though presided over by a harassed superman of a scientific manager.

RALPH E. FLANDERS.

The Engineer Cabinet Member

IN placing Herbert Hoover in nomination for the presidency of The Federated American Engineering Societies at Washington, Dean Kimball said that at Leland Stanford University, when Hoover was a student there, it was recognized by those who knew him that "here was a man who would go very far and achieve much in whatever field of activity he might be placed." Mr. Hoover's entry into the Cabinet is but another step in the fulfilment of that prophecy—a step which will be especially gratifying to all engineers in every country of the world.

For Herbert Hoover belongs not exclusively to America, but, in a peculiar sense, to the whole civilized world. He has not been chosen for this new honor simply because he is an engineer, but because of his demonstrated capacity for rendering service of an exceptional character. In short, because he is Herbert Hoover, unselfish, devoted organizer and director of the world's greatest benefaction, preeminent preserver of human life and of faith in human nature.

His fellow-engineers will rejoice in the fact that added to his personal and natural ability have been the training and experience of the engineer with the habit of a clearly defined objective, of marshaling all possible forces of personnel and matériel for the attainment of that objective and directing them in such manner as to secure the hearty, whole-souled devotion and coöperation of myriads of men and women.

His recognition is not based upon partizan political service, past or prospective, but upon the world's conviction that this engineer possesses in preeminent degree the ability to perceive what needs to be done and to organize and direct the means of doing it. Especially have the newly enfranchised women of the country insisted that his genius should be enlisted in the service of the people, and in this they have shown an ability and disposition to recognize genuine service to humanity and to the social order which must be reckoned with by those who in all future times may endeavor to guide political affairs.

By tradition our public offices have been filled mostly by men whose training has been in the law. There have been many good reasons for this, but the time has come when the constructive and directing ability of the engineer is required for the solution of our present-day problems, which are largely brought about by changes in our manner of life resulting from the work of engineers. It seems certain that in greater and greater numbers engineers will be called to serve the people in public office.

Mr. Hoover has set his own high standard of public service and his responsibility to the public will be correspondingly great. We may be sure that his only conception of rendering real service to the administration of which he is a member will be to render a real and genuine service to the people of the country, without regard to partizan considerations.

Whether or not Mr. Hoover is to be followed by a long line of engineers in high and responsible official positions, depends now far more upon him and how he shall conduct himself during his term of office than upon anybody or anything else. His responsibility on that score is to the engineers not only of the United States but of the entire world, all of whom are familiar with his achievements and know that they will be themselves appraised more or less by the degree to which he is successful. Fortunately, no engineer will for a moment doubt that this responsibility also will be most faithfully and competently discharged.

FRED J. MILLER.

The Unstabilized Dollar and Efficient Management

THE most striking feature of Professor Irving Fisher's address, How an Unstabilized Dollar Interferes with Efficient Management, at the Springfield, Mass., meeting of the Taylor Society, was the response of the audience of practical plant executives and industrial engineers. It was evident that those who are charged with managerial responsibility in industry have come to appreciate that here is a problem which should no longer be classed as merely "academic." The responsiveness of the audience was no doubt in part due to Professor Fisher's great ability as a speaker

—he is unexcelled in clear and interesting presentation—but it was also due to the timeliness of the discussion. One who has just come from the painful task of writing off inventories following the violent price fluctuations accompanying the change from a sellers' to a buyers' market, is ready to consider as practical and urgent the question whether defects in the monetary system may not be in part responsible—and may not be remediable.

Professor Fisher's discussion followed the well-known and unexcelled four-part outline usually employed by the late Professor Sumner. In answer to the question, What is it? the attention of the audience was called to recent general price fluctuations as evidenced by that new instrument of precise measurement, the index number. In answer to the question, What causes it? the author called attention to the fact that in the United States the value of a dollar is the value of 23.22 grains of gold, and that as the quantity of gold and media of exchange based on gold, including credit tokens, increases in volume, more gold and therefore more dollars will be offered for other commodities (higher prices), and that as the quantity of gold and media of exchange based on gold decreases, less gold and therefore fewer dollars will be offered for commodities (lower prices). In answer to the question, What of it? Professor Fisher reminded the audience of the unwholesome, feverish business activity which results from violent increases in general prices, the stagnation resulting from the uncertainty accompanying violent decreases in prices, the losses to recipients of fixed income—bondholders and salaried persons—in times of price increases, the losses to owners of businesses—stockholders and farmers—in time of price declines, and in general the unfavorable influence on establishing and carrying forward managerial plans in the face of price changes one way or the other. Taking up last the question, What are you going to do about it? the speaker explained his own proposition for stabilizing the dollar and argued that as a practical problem of establishing a better environment for promoting stable conditions for good management the business community should encourage the legal adoption of it or of an equivalent method of solving the problem.

Professor Fisher's plan is to change the law, so that instead of a dollar always having the value of 23.22 grains of gold, the amount of gold which shall have the value of a dollar shall be periodically automatically changed as *general* prices change, as measured by the index number; as prices tend to go up, more gold, as prices tend to decline, less gold, shall have the value of a dollar. The result would be to maintain the quantity of dollars to be offered for commodities stationary, even though the quantity of gold might change. In that way, Professor Fisher believes, *general* prices can be kept fairly stationary. And stable general prices will create a better environment for administrative and managerial plans and activities—a better opportunity for developing generally more precise and therefore better management.

It is essential that business executives and engineers give more thought to such problems. Their traditional attitude is to consider outside their range of interests a study of the social forces which determine the limits of their managerial activities. Unfavorable social conditions they consider "acts of God" which may not be influenced and to which they must submit. They are as a matter of fact generally the acts of men.

The reaction to Professor Fisher's address gave evidence that engineers and executives are showing a greater interest in general economic problems and a disposition to bring their influence to bear on stabilizing the conditions under which they must conduct their business activities.

H. S. Person.

San Francisco–New York Mail Delivery and the Railroads

THE recent success in delivering mail from San Francisco to New York by aeroplane in less than 34 hours is of considerable interest, not only in aeronautics but in relation also to railroading.

Beginning 20 years ago, and up to the time of the war, vigorous efforts were made to increase the speed of passenger and mail transportation by rail. In Europe the effort was directed to determining the maximum possible speed of transportation with electric locomotives, and in tests at Zossen, Germany, a speed of 200 kilometers (124 miles) per hour was attained. The requirements of operation, however, were so severe as to show the utter impracticability of such speeds for regular traffic, especially when of transcontinental character.

In America the steam locomotive was relied upon to give the fastest possible transportation, but as early as 1910 there began to be the feeling that we had very nearly reached the limit of speed compatible with safety, and that the disturbance to regular traffic occasioned by these fast trains more than offset any advantages which might accrue. This feeling found expression in the addition of two hours of traveling time to the crack New York Central trains between New York and Chicago.

It costs money to lop off even one hour's time between New York and Chicago; and it would cost proportionately more to reduce the time, say 10 hours, between New York and San Francisco, involving as it would a large permanent investment for improvements in roadbed and roadbed equipment, additional trackage at stations, etc.

As long as rail transportation was the only means available for transcontinental traffic there might have been good reasons for going to such expense, but the wisdom of such a course becomes more and more doubtful with the development of aerial service.

While as yet the aeroplane and dirigible are far from being competitors of the railroads, there is every reason to think that one or both will become so for long-distance high-speed mail and passenger traffic, just as the motor truck has become a competitor in short-haul freight transportation—and this within a very few years. This is all the more to be expected from the fact that the demand for high-speed traffic over long distances is at present comparatively small in volume.

The fast letter mail has already been practically taken off the ground. An interesting example of what is being accomplished by the mail service as now established is the reported receipt of a letter at the Engineers' Club, New York, 50 hours after it was mailed at Los Angeles. This letter traveled by aeroplane by day and by train at night, apparently via Omaha and Chicago.

In case the appropriation should be forthcoming, the Post Office Department is stated to have plans for a regular 36-hr. service from San Francisco to New York on the strength of the showing already made.

It will very likely take a good deal longer to lift off the ground the high-speed passenger traffic, but there is scarcely any doubt that this is coming, and, this being so, it does not seem likely that the railroads will ever incur the heavy investment and expense of operation that would be required to cut even half a day from the time between New York and San Francisco, when the chances are that air transportation would cut off two days.

There also looms in the distance the possibility that by utilizing the high-velocity winds apparently ever present at great altitudes, the transcontinental timetable may become a matter of hours rather than of days. It was whispered last fall that the War Department would try during the coming summer a dirigible trip from San Francisco to the Atlantic Coast to follow a trail, say, 30,000 to 35,000 ft. high, with the expectation of making the trip within the scarcely believable time of 10 hours from start to finish.

Progress Report on Superpower Survey

A report submitted late in February to President Wilson by John Barton Payne, Secretary of the Interior, outlines the work which has already been accomplished and indicates what is yet to be done by the Geological Survey in its study of methods for the further utilization of water power and the special investigation of the possible economy of fuel, labor, and materials resulting from the use in the Boston-Washington industrial region of a comprehensive system for the generation and distribution of electricity to transportation lines and industries.

An engineering staff, with William S. Murray as chairman, assisted by an advisory board of business and professional men, of which Prof. L. P. Breckenridge is chairman, is making a thorough study of the problem in its physical, legal and financial aspects. An editorial outlining the plan of study, describing the field, and naming some of those engaged in the work, was given in the November 1920 issue of Mechanical Engineering, p. 642. It is believed that the complete report will be available in July.

The Material-Handling Problems of Ports

Interesting Meeting Held at Newark Under the Auspices of the Materials Handling and Metropolitan Sections of the A.S.M.E.

THE Materials Handling Section presented a program under the auspices of the Metropolitan Section at a meeting held in Newark, N. J., on the evening of March 4, 1921. Following dinner at the Robert Treat Hotel, about 700 members gathered at the Public Service Terminal Building to hear a series of papers devoted to a discussion of the material-handling problems of port operation. The first paper was presented by B. F. Cresson, Jr., chief engineer, N. Y., N. J. Port and Harbor Development Commission.

Mr. Cresson presented the fundamental considerations in the development of a port, upon which the remainder of the program, relating particularly to the use of material-handling apparatus and methods, was built.

Mr. Cresson pointed out that a world-trade port should be able to handle great volumes of business and great varieties of commodities. A great port should comprise a protected deep-water harbor, a substantial length of waterfront, a hinterland of industrial importance, a system of railroad and inland waterway connections to a large producing territory, a good labor market and an appreciation by the political government of the necessities in the layout, ownership and administration of the port facilities. A form of port administration should direct the growth and operation of the port, making it as cheap and easy as possible for commerce to enter and to leave, not seeking to obtain high revenue from the operation of port facilities, but developing them and using them rather as a means to build up the territory tributary to the port. There must be facilities for the handling of bulk commodities and there must be the necessary equipment for the handling of the miscellaneous package freight.

The problem that the port engineer is usually confronted with is the layout within an operating port district of terminal facilities that will best coördinate the transportation lines, both land and water, centering at the port, and in so doing to create a district in which business may expand. Mr. Cresson spoke of the zoning of ports, first, by the segregation of large commodity business, and second, by the segregation into separate districts of business in principal trade routes.

In the development of a port there must be considered, first, the proper location of the terminals; second, the physical layout of the terminal facilities; third, the equipment of the terminal facilities; and fourth, the administration and operation of the port as a whole. The layout of a terminal should depend upon the character of business to be handled, the ships and other craft that are to dock there, and the location of the railroads and highways. These factors affect the width and height of the piers, the placing of tracks, the building of sheds, the width of slips, etc. In some instances the quay system is superior to the pier system. In any case a port must be made up of many different parts, and these should be coördinated not only in their location, design, layout and equipment, but also in their general administration and operation.

The speaker pointed out the importance of the Port Newark Terminal and emphasized the possibility of the construction of a modern terminal that will develop industries and permit rapid and cheap interchange of freight between rail and water carriers.

Treating the subject of Machinery for Cargo Handling, J. A. Shepard, vice-president of the Shepard Electric Crane & Hoist Co., outlined the development of devices for moving cargo in and out of the holds of ships, indicating the limitations which the necessity of stowing away cargo by hand power imposed and discussing some types of pier machinery. Mr. Shepard made a plea for the development of smaller but more efficient terminal units, thoroughly equipped with mechanical apparatus giving efficient results and large output per unit.

E. Logan Hill, of Heyl & Patterson, Inc., in discussing Car Loading and Unloading Machinery, confined his remarks to apparatus suitable for handling miscellaneous package freight from box and open-type cars to platforms, piers, lighters, and steamships.

Mr. Hill traced the progress in the manner of unloading such material from cars, through the steps of hand labor and hand-operated derricks, steam locomotive cranes, to specially designed electrically operated cranes. Three distinct types of electric cranes were mentioned as satisfactory for this work. These are, in the order of their efficiency and first cost:

1 A steel gantry structure, spanning one or more tracks and having mounted thereon apparatus which to all effects and purposes is the same as the locomotive crane without the boiler and steam engine, the motive power for hoisting the load, rotating the crane and luffing the boom being supplied by one motor with a multitude of clutches, brakes, brake bands, gear levers, etc.

2 The so-called straight-line crane, which consists of a tower structure and a boom which in operating position is held in a horizontal plane and has no provision for working at any other angle and is incapable of being rotated about a central point.

3 The full-arch or semi-portal traveling revolving jib crane.

The speaker then went on to discuss a typical installation of an open-type railroad pier approximately 1000 ft. long and 80 ft. wide, on which were placed a number of parallel tracks. Eight steam locomotive cranes were replaced by four traveling full-arch revolving jib electric cranes having separate motors for each of the several movements such as hoisting, rotating and traveling. The maintenance charge of the eight locomotive cranes for twelve months was practically $34,000. The four electric cranes which replaced the locomotive cranes had a maintenance charge of $7500 after they had been in service for nearly four years. The four electric cranes actually handle more material than was ever handled by the eight locomotive cranes. They require 14 less men, which, taken into consideration with the increased amount of material handled, resulted in a total saving per annum of approximately $45,000.

The portal structures of these cranes are designed so as to span two railroad tracks, their movement up and down the pier is entirely independent of any switching movement, and their booms are of such length that they can reach any car on any one of the five tracks of the pier.

In concluding the discussion, R. S. Parsons, general manager of the Erie Railroad, called attention to the great importance of co-operative action on the part of the people of New Jersey in the development of a port of New Jersey. He contrasted the action in New York, where three counties are combined under one specific head, with the situation in New Jersey, where some 15 separate municipalities are struggling with jealousies and petty problems and the great problems are ignored.

Between the presentations of the papers reels of moving pictures of New York Harbor and of Newark Bay were shown

Four Test Codes for A.S.M.E. Spring Meeting

A.S.M.E. Codes must be presented for adoption by the Society at a regular meeting. A feature of the Chicago Meeting will be a session devoted to the consideration of the proposed Power Test Codes on General Instructions, Reciprocating Steam Engines, and Evaporating Apparatus. This session will be in the nature of a public hearing, and every one who is interested in these Codes or in any one of them is invited to be present and take part in the discussion. The Code on General Instructions appeared in the December issue of MECHANICAL ENGINEERING; the Code on Reciprocating Steam Engines in the January issue, and the Code on Evaporating Apparatus in the March issue. Written discussion on all of these Codes is also invited from those who are unable to attend the Power Test Code session, and should be addressed to C. B. Le Page, Secretary to the Committee, 29 West 39th Street, New York.

The Elimination of Waste in Industry

Purpose and Plan of Work of Committee Appointed by Herbert Hoover, President of The Federated American Engineering Societies

THE membership of The Federated American Engineering Societies consists of national, local, state and regional engineering and allied technical organizations and affiliations. Such national engineering societies as The American Society of Mechanical Engineers, American Institute of Electrical Engineers, and the American Institute of Mining and Metallurgical Engineers, are members of The Federated American Engineering Societies.

The object of the organization, as quoted from the Constitution,

> . . .Shall be to further the public welfare wherever technical knowledge and engineering experience are involved, and to consider and act upon matters of common concern to the engineering and allied technical professions . . . . . A comprehensive organization of the community, state and nation.

The Committee on Elimination of Waste in Industry came into existence from a speech in Washington by Mr. Hoover, in November, in which he said:

> It is primary to mention the three-phase waste in production: first, from intermittent employment; second, from unemployment that arises in shifting of industrial currents; and third, from strikes and lockouts. Beyond this elimination of waste there is another field of progress in the adoption of measures for positive improvement in production.
>
> In the elimination of the great waste and misery of intermittent employment and unemployment, we need at once coördination in economical groups . .

In an executive meeting of the American Engineering Council, Mr. Hoover further discussed the need for an intensive study being made of all causes for industrial waste, emphasizing those factors that contribute to labor or man-power waste. He suggested to the Council, which is the governing body of The Federated American Engineering Societies, the advisability of appointing a committee of fifteen carefully selected engineers to undertake a study of waste in industry. The American Engineering Council readily approved the suggestion of Mr. Hoover, whereupon he they formed the Committee on the Elimination of Waste in Industry.

In selecting the personnel of this Committee, care was exercised to secure men of broad experience, of clear concepts, of unbiased attitude toward labor problems and representative of managerial, consultant, educational and editorial activities, as well as having a widely distributed and a varied industrial contact.

At the organization meeting of the Committee in January, its purpose was stated to be—

1 To determine the cause of labor, material and equipment waste in industry. The material and equipment phases of the problem to be studied only in so far as they may cause labor waste.

2 In so far as possible to determine the extent of the waste that arises through each major cause.

3 To suggest means of removing the cause for such waste.

To accomplish the purposes of the Committee, it has been found necessary to make studies along the following lines:

1 Organization—that which assigns responsibilities and relationships, and the discharge thereof.

2 Engineering—which comprises the design, construction and maintenance of plant, machinery and tools and the design of the product.

3 Production Control and Cost Control. Under this division fall all the factors relating directly to production and the proper direction and accounting therefor.

4 Physical Factors. This division relates to the storage and inspection of raw and processed materials and to matters of internal transportation. It also includes consideration of the physical condition of the plant as regards lighting, heating, toilet facilities etc.

The first and third sections, as well as the principal part of the fourth, directly relate to the human element in industry. The Committee is devoting the major portion of its effort to the factors that affect the human element.

The important subdivisions of the major factors—organization, production control and cost control,—to which special attention is directed, are enumerated below.

ORGANIZATION

(a) *Nature of operation:*

1 Contractual. This form presents many problems that affect personal relations. Building operations largely contractual. This form of relationship is quite common in the clothing industry.

2 Repetitive. A large portion of industrial activity is repetitive. This phase of industry makes prominent the question of monotony, and occupational diseases.

3 Continuous. Steel and chemical industries are typical representatives. In this form of operation the question of the number of shifts is considered important.

(b) *Types:*

The type of organization is some index to the quality of the management and as such is an essential consideration.

1 Functional
2 Line and Staff
3 Staff
4 Mixed
5 Committee.

(c) *Personal Relations:*

1 Employment Policies

2 Representation—To what extent each plan has been tried, and with what results:

a Federal plan
b Joint committee
c Employees'coöperative association.

3 Strikes and Lockouts—The case for, the duration of, the man-hours lost, and the total cost.

4 Restrictions by Management and Labor—An investigation of the means employed by management and by labor to restrict production. Such practice produces an unstable condition and hence leads to uncertain labor conditions and disturbed relations.

5 Unemployment
a Quantity of
b Causes of
c Remedy for.

6 Seasonal and Intermittent Employment
a Quantity of
b Causes of
c Remedy for.

PRODUCTION CONTROL AND COST CONTROL

(a) *Planning:*

All of these factors have a direct influence upon the productivity of the individual worker. If inadequately or ineffectively provided for, the worker loses time and compensation, hence a high morale is not sustained.

(b) *Establishing Standards:*

This is very significant, as many labor disputes have arisen over the method and fairness used in establishing such standards. They have a direct bearing upon the earnings of the worker.

(c) *Maintenance:*

If equipment is not properly maintained, the operator does not accomplish standard tasks, hence dissatisfaction results

Industries to be Studied. The representative industries which have been selected because of their general importance and interest to the public are as follows:

1 Bituminous Coal	6 Paper
2 Building Trades	7 Metal Trades
3 Transportation	8 Textiles
4 Men's Ready-Made Clothing	9 Shoes
5 Printing	10 Rubber

From three to ten plants of each selected industry are being visited by an experienced engineer, who will secure the information desired by the Committee. A carefully prepared list of questions has been placed in the hands of each field worker. The information obtained by the field investigator is to be supplemented by such authoritative data as may now exist in the form of reports made by reliable parties or agencies. Through this means sufficient information is to be secured to enable the Committee to formulate specific conclusions as to the major causes of industrial waste.

Staff. A small staff is to be maintained at headquarters. This staff plans and directs the work. The field work is to be done by engineering firms carefully selected for their fitness for the work. For example, the investigation of ready-made clothing was assigned to a firm that has had a large experience in that field. Thus the

Committee will obtain the benefit of the experience and knowledge of the firm that has had most intimate contact with a given industry. The firms are doing the work at actual cost to them, all profit being waived.

All authoritative literature upon each general topic is to be carefully searched and digests made by well-qualified firms. The headquarters staff will compile all the data and write the final report, which is to be reviewed by the Committee as a whole. Every effort is to be made to secure authentic and quantitative information, and care will be exercised to prevent any bias or prejudice from influencing any phase of the work.

Progress of Work. The work of the Committee is well under way. Reports on the first investigation in each industry were made on February 21, carrying out the time schedule set February 7. At a meeting of the Planning Board held on March 1, further reports were presented and plans made for continuing the investigations more intensively. These reports were uniformly encouraging and there is every reason to believe that the investigation will yield information that will have an important bearing on the nation-wide movement inaugurated by the engineer to eliminate waste in American industry. In New York, New England and Pennsylvania the fuel investigation is practically completed.

Engineers Asked to Urge Reconsideration of Nolan Patent Office Bill

The following report of the Patent Committee of the American Engineering Council is of importance to all engineers and should receive their immediate attention. The Patents Committee, in submitting the report, asks that every member of each of the constituent societies of The Federated American Engineering Societies immediately write his representative and his senators and the chairmen of the Committees on Patents of the Senate and the House of Representatives, urging the reintroduction and passage of the Nolan Patent Office Bill without the section known as the Federal Trade Commission section.

The bill for the imperatively necessary relief of the Patent Office, after passing the House of Representatives with satisfactory provisions for the Patent Office, failed to pass the Senate at the session just closed with those same provisions, solely because of the presence in it of an unrelated section known as the Federal Trade Commission Section.

The former opposition in the Senate to the Patent Office relief and that which forced the unacceptable reductions in salaries and numbers of examiners and clerks (which the Conference Committee was persuaded to set aside) is largely and seemingly almost wholly overcome. But the opposition in the Senate to the Federal Trade Section is determined and has expressed an intention to prevent the Patent Office from getting the desired relief, unless the Federal Trade Section is removed from the bill.

More than preventing the Patent Office relief, however, the Federal Trade Section is believed to be a dangerous measure in itself. It provides that the Federal Trade Commission may receive assignments of and administer inventions and patents from governmental employees and is an entering wedge for further legislation to empower the Trade Commission to receive patents from non-governmental inventors or owners. An exclusive license would have to be granted, at least for a few years, to induce any one to undertake the almost always necessary development expense, and the Trade Commission would surely be charged with favoritism in granting such a license. In order to protect its licenses, the Trade Commission would have to sue infringers, a most unfortunate activity for the Government. The industries would close their doors to the government employees, fearing to disclose to them their secrets or unpatented inventions, and research by the industries would be discouraged for fear that government employees, using government facilities, might reach the result first and patent it. The Trade Commission, owning a large body of patents, in case that one of its patents was found to be infringed during or at the close of a frequently very expensive development by private interests would be able to dictate in the license the price at which the article, which was the object of the development, could be sold, or to dictate other similar conditions, thus depriving the development of much of its value; and could even require the licensee, as a condition for granting needed license, to practically destroy some of its unrelated patents, as by licensing the trade generally when it would prefer to retain the monopoly for itself.

The foregoing and other objections would result in making patents less desirable to own or to purchase, and consequently would decrease the incentive to produce inventions, which production is the main purpose of our patent system.

The proposed section is unnecessary for the protection of government employees, since they now have all the rights which non-governmental employees have to patent inventions and to sell them. It is therefore believed that the Federal Trade Commission section should not be enacted into law in any form, even as a separate bill.

Award of Kelvin Gold Metal

The first triennial award of the Kelvin Gold Medal has been made to Dr. William Cawthorne Unwin, F.R.S., of London, for his preeminence in the branches of engineering with which Lord Kelvin's scientific work and researches were closely identified. The Kelvin Gold Medal as instituted eight years ago when the leading engineering societies of the world coöperated in securing a memorial to Lord Kelvin, a distinguished engineer and man of science. The major memorial took the form of a window in Westminster Abbey. The Kelvin Medal was established from the remainder of the memorial fund. The Kelvin Gold Medal Fund is administered by the Institution of Civil Engineers. The committee making the award, in accordance with the conditions of the Kelvin Medal Trust, consisted of the presidents of the principal representative British engineering institutions.

Dr. Unwin has been professor of mechanical and hydraulic engineering at the Royal Indian Engineering College and professor of engineering at the Central Technical College of the Guilds of London. He is a past-president of the Institute of Civil Engineers and an honorary member of The American Society of Mechanical Engineers.

Dr. Unwin has done work of great importance in the development of precise methods of testing, in connection not only with materials but also with all types of power plant. The standardization of specifications now being carried on by the British Engineering Standards Association owes much of its success to his pioneer work. In the work of coördinating results of experience in engineering design, in the development of centrifugal pumps and the hydraulic generation of power, in increasing the efficiency of heat engines, and in machine design, the influence of Dr. Unwin, both as a writer and as a teacher, has been far-reaching.

Engineer Appointed to Public Service Commission of Maryland

Governor Ritchie of Maryland has recently announced the appointment of Ezra B. Whitman, civil engineer, and president of the Engineers' Club of Baltimore, as one of the three public-service commissioners of the state. In the announcement emphasis was laid particularly on the desirability of having a trained engineer on this board.

Mr. Whitman was graduated from Cornell University in 1901, and afterward took special courses in chemistry and bacteriology in the Cornell Medical School, New York. From 1902 to 1905 he was a member of the firm of Williams and Whitman, of New York City. From 1906 to 1911 he acted as division engineer for the Sewage Commission of Baltimore, in charge of the design and construction of the sewer systems for that city. From 1911 to 1914 he served as chief engineer and president of the Water Board of Baltimore City, in charge of the maintenance, operation and extension of the system. From May 1914 to May 1916 he was a member of the firm of Greiner and Whitman. Since 1916 he has been a member of the firm of Norton, Bird and Whitman, who have carried on a very extensive practice as consulting civil engineers. During the war he was officer in charge of utilities at Camp Meade, with rank of major, and was responsible for practically the whole of the operation and maintenance of that large camp.

Mr. Whitman is a member of the American Society of Civil Engineers, American Water Works Association, American Public Health Association, New England Water Works Association, American Association of Engineers, and the Engineers' Club of Baltimore. His appointment has been a matter of very considerable gratification to friends and fellow engineering associates in Baltimore, where it is felt that considerable advantages will accrue from the presence of an engineer on the Public Service Commission.

A Correction

A. E. Hall has called attention to the fact that in the discussion of his paper in the February issue of MECHANICAL ENGINEERING, page 101, the 54 to 60 in. dimensions referred to *circular* saws and that the 3-hp. and 4-hp. should have read 300-hp. and 400-hp.

Engineering and Industrial Standardization

Campaign Against Industrial Accidents

DURING 1921 the members of the National Safety Council are for the first time attempting a unified and intensive accident-prevention campaign. Formerly safety campaigns have been conducted independently in each of the 8000 member plants of the council, and although much has been accomplished by these scattered campaigns, there are still approximately 22,000 workers killed and 600,000 injured in industrial accidents each year.

The plan announced at the headquarters of the council in Chicago calls for a concentrated attack, through all available means, on a different hazard each month. Thus during January, in approximately 8000 industrial plants, mines, railroads and other public utilities throughout the country, a special campaign was conducted against ladder accidents. The February campaign was against neglect of minor injuries and infections arising therefrom, and the March campaign dealt with unsafe clothing. The campaigns announced for the other months are as follows: April, horse play; May, hand-tool hazards; June, standing or sitting in dangerous places; July, machinery hazards; August, inattention; September, fire; October, health hazards; November, careless handling of materials; and December, eye injuries.

Safety Code for Logging and Sawmill Machinery

For a number of months the Bureau of Standards, at the request of the American Engineering Standards Committee, has been organizing a Sectional Committee to formulate a safety code for logging and sawmill machinery. The personnel so far determined is as follows:

Name and Address	Association, Society or Firm Represented
Manufacturers' Organizations:	
W. Graham Cole, director of Safety and Industrial Relations	Southern Pine Association
Frank H. Lamb, president Wynooche Timber Company	Pacific Logging Congress
Dr. Wilson Compton, manager	National Lumber Manufacturers Association
.....	West Coast Lumber Association
Individual Manufacturers:	
Kenneth Rushton, chief engineer	Baldwin Locomotive Works
W. G. Hagmier	Allis-Chalmers Company
J. S. Reid, president	Clark Brothers Company
State Authorities:	
H. M. Wolflin, Cal. James C. Cronin, Pa. Richard J. Cullen, N. Y. C. H. Younger, Wash. R. A. McA. Keown, Wis. C. H. Gram, Ore.	International Association of Industrial Accident Boards and Commissions
Government Bodies:	
Col. W. B. Greeley, Forester	U. S. Forest Service
E. H. Finlayson	Canadian Forest Service
E. B. Rosa M. G. Lloyd J. A. Dickinson	Bureau of Standards
Safety Engineering Organizations:	
Joseph H. Dickinson, Lidgerwood Manufacturing Company	American Society of Mechanical Engineers
C. W. Price, general manager	National Safety Council
Carl O. Hero, safety engineer, Lumber Mutual Casualty Insurance Company	American Society of Safety Engineers
Insurance Organizations:	
W. H. Cameron, secretary-treasurer	Workmen's Compensation Service Bureau
H. F. Richardson	National Council on Workmen's Compensation Insurance
Carl O. Hero, safety engineer, Lumber Mutual Casualty Insurance Company	National Association of Mutual Casualty Companies
Civic Associations:	
P. S. Risdale, secretary	American Forestry Association
.....	International Union of Timber Workers
Dr. Thorfinn Tharaldsen	Loyal Legion of Loggers and Lumbermen
Professional Societies:	
Prof. E. T. Clark, University of Washington	Society of American Foresters
Individual Experts:	
Major Swift Berry, Timber Appraisal Section, U. S. Treasury Department	
A. R. Lawrence, manager, Virginia State Rating Board	
John H. Foster, N. H. State Forester	
Robert Stanley, safety engineer, Parker-Young Co., Lincoln, N. H.	
W. D. Scruggs, efficiency and safety engineer, Great Southern Pine Company, Bogalusa, La.	
David Van Schaack, director, Bureau of Inspection and Accident Prevention, Aetna Life Insurance Co.	

Safety Code for the Protection of Head and Eyes

Attention is called to a new publication of the Bureau of Standards, Handbook No. 2, entitled National Safety Code for the Protection of the Head and Eyes of Industrial Workers. This is a set of rules designed to give mechanical and optical protection to the eyes of workers in certain occupations which involve an eye hazard. The rules have been worked up in coöperation with outside conferees representing all points of view and especially with the assistance of an Advisory Committee which has approved the draft of the rules.

A copy of this code may be obtained by addressing the Bureau of Standards, Washington, D. C. If desired in quantity they may be obtained at a small charge from the Superintendent of Documents, Government Printing Office, Washington, D. C.

Industrial Lighting Code

At the March 6, 1920 meeting of the American Engineering Standards Committee the Illuminating Engineering Society was requested to form a Sectional Committee for the development of an Industrial Lighting Code and to assume sponsorship therefor. This society accepted the responsibility and has submitted the names of the members of the Sectional Committee to the A. E. S. C. The interests included in this Committee and the number of representatives assigned to each are as follows: state commissions (1), gas and electric companies (3), insurance interests (2), federal bodies (2), other general interests (3), manufacturers of lamps (2), and consulting engineers (3).

The members of the Sectional Committee are: L. B. Marks (Chairman), W. T. Blackwell, W. F. Little, R. E. Simpson, G. H. Stickney, W. J. Serrill, Prof. C. E. Clewell, Dr. Louis Bell, Dr. A. S. McAllister, G. B. Regar, Dr. M. G. Lloyd, Dr. Thomas C. Eipper, C. L. Law, W. D. Keefer, W. H. Cameron, and Dr. J. W. Schereschewsky.

Copper Specifications

The American Society for Testing Materials has submitted the following copper specifications to the American Engineering Standards Committee for approval:

Specifications for Soft or Annealed Copper Wire (B3–15).

Specifications for Lake Copper Wire Bars, Cakes, Slabs, Billets, Ingots and Ingot Bars (B4–13).

Specifications for Electrolytic Copper Wire Bars, Cakes, Slabs, Billets, Ingots and Ingot Bars (B5–13).

Methods for Battery Assay of Copper (B34–20).

Specifications B3–15, B4–13 and B5–12 may be found in the 1918 volume, and Specifications B34–20 in the 1920 volume of A. S. T. M. Standards. Copies of these may also be obtained from the American Engineering Standards Committee, 29 West 39th Street, New York.

News of Other Societies

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS

Annual meeting in New York, February 14–17. Iron and steel topics were extensively discussed. Two sessions were held on the breakage and steel treatment of drill steel, at which Benjamin F. Tillson, of the New Jersey Zinc Co., Francis B. Foley, of the Bureau of Mines, and Frank H. Kingdon, of Sullivan Machinery Co., presented papers dealing with the mechanics of failure of materials, and C. W. Burrows, of The Dorr Co., an illustrated report of an investigation on the fatigue of drill steel by magnetic survey and magnetic analysis. The discussion led to a resolution that the Institute establish a board in coöperation with other engineering societies and Government agencies to investigate the breakage and heat treatment of rock-drill steel and other steels subjected to similar stresses. This resolution was passed unanimously and will go to the board of directors for action. Two other sessions were held on iron and steel at which questions dealing with the manufacture and metallurgy of these metals were taken up. Some of the papers presented were: Static and Dynamic Tension Tests on Nickel Steel, by J. J. Thomas and J. H. Nead; Measurement of Blast-Furnace Gas, by D. L. Ward and R. S. Reed; Importance of Hardness of Blast-Furnace Coke, by Owen R. Rice; Manufacture of Ferromanganese in the Electric Furnace, by Robert M. Keeney and Jay Lonergan; Electric Furnace in the Iron Foundry, by Richard Moldenke; Surface Changes of Carbon Steels Heated in Vacuo, by E. H. Hemingway and G. R. Ensminger; and Molybdenum Steels, by John A. Mathews.

One entire session and parts of others were devoted to industrial relations. Among the papers presented were one on the Hiring and Placing of Men, by S. R. Reetanus, and another on Dust Ventilation Studies in Metal Mines, by D. Harrington. Sessions were held also on mining and milling, coal mining, non-ferrous metallurgy, non-metallic minerals, and petroleum and gas. The list of papers presented at these sessions included: Relation of Air Pressure to Drilling Speed of Hammer Drills, by H. W. Seamon; Skip Hoisting for Coal Mines, by Andrews Allen and J. A. Garcia; Steel Chimneys and Their Linings in Copper Smelting Plants, by A. G. McGregor; By-Product Expansion in the Non-metallic Mineral Industries, by Oliver Bowles; and Effect of Temperature, Deformation, Grain Size, and Rate of Loading on the Mechanical Properties of Metals, by W. P. Sykes.

The papers by J. J. Thomas and J. H. Nead, H. W. Seamon, and W. P. Sykes are abstracted in the Survey Section in this issue.

At the banquet, Herbert Hoover, retiring president, delivered a brief address in which he reviewed the activities of the Institute during the past year. Edwin Ludlow, New York, the incoming president, spoke on the present labor conditions in the United States.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Annual meeting in New York, February 16, 17 and 18. President A. W. Berresford, in his address, reviewed the role of the engineer in modern civilization, calling attention to the rapid growth in magnitude of modern enterprises and the increasing application of science to all phases of life. The complicated civilization of the present day exhibits the process of association at its maximum and the engineer is being forced more and more into closer coöperation with his professional brothers. The day has past when he can grapple alone with the engineering problems of the times. They must now be solved by the profession as a whole, and herein lies the secret of the growth of engineering societies, which represent the concrete answer to the call for coöperation. At the same time, the spirit of association inevitably fosters the substitution for the motive of private interest the noble purpose of unselfish public service.

A notable feature of the meeting was the presentation of the Edison medal to Dr. Michael I. Pupin of Columbia University, "for work in mathematical physics and its application to the electrical transmission of intelligence." Upon receiving the medal, Dr. Pupin gave an address on Wave Transmission, in which he described some of his early experiences in Serbia and various incidents of his life and education leading up to his telephonic inventions. Numerous papers dealing with electrical subjects were presented at the technical sessions.

TAYLOR SOCIETY

Meeting at Springfield, Mass., February 24, 25, and 26. Professor Irving Fisher, of Yale University, explained how the instability of the dollar interferes with efficient industrial management, inasmuch as changes from prosperity to depression cause uncertainty and restriction of management activities. The committee on sales quota of the sales management section of the society submitted a preliminary report. A "sales quota" is a predetermined amount of business to be obtained in a given period by the sales department as a whole, by any branch of the department, by any individual salesman, in the entire country or in any state, county, city, sales district or subdivision of these. The determination of quotas, their apportionment and the results of the system were explained in detail. Meyer Bloomfield, in a paper entitled The Development of our Conception of the Function of Personal Administration, surveyed the progress in industrial management during the period from 1910 to the present year. Symposia were held on storekeeping, planning, layout and standardization of equipment, and analysis and standardization of manufacturing processes.

ENGINEERING INSTITUTE OF CANADA

Annual meeting at Toronto, February 1, 2 and 3. Considerable attention was given to the proposed legislation for the registration of engineers in Canada. Through the efforts of the Institute registration laws have been adopted in each of the Canadian provinces, except Saskatchewan, Prince Edward Island, and Ontario. Work is well under way in these provinces, however, toward the successful passage of such legislation. The committee on international relations reported that arrangements had been completed with The American Society of Mechanical Engineers for an indefinite term and with the American Institute of Mining and Metallurgical Engineers for one year, whereby these societies and the Canadian Institute will mutually exchange privileges of publications; that is, any member of these American societies may obtain the publications of the Institute at the same price as that paid by the members of the latter organization, and vice versa.

NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION

Meeting at Cleveland, February 24, 25 and 26. Cost accounting of machine-tool plants was the chief topic of discussion. A report by Scovell, Wellington and Co. outlined a plan for standard methods of cost accounting which included such items as interest on invested capital, rent on buildings, cost of drawings, patterns, jigs and fixtures, cost of idleness, normal burden and unearned burden, and other points necessary to know total costs. Fred A. Geier showed by figures compiled from 70 important companies for the ten years prior to 1913 that the net returns averaged 9 per cent on the invested capital. Since that period, careful estimates place the net returns at $10^1/_2$ per cent. E. J. Kearney recommended the use of the budget system for recording expenses and keeping them within the proper limit. Ernest F. DuBrul outlined a program for the association to undertake, in coöperation with The American Society of Mechanical Engineers and other technical societies, along such lines as the standardization of machine tools and the organization of industrial research.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION

Meeting at Cleveland, February 22. Committee reports on standard specifications for setting return-tubular and water-tube boilers were presented. Charles E. Gorton, chairman of the Uniform Boiler Law Society, reported on the recent Detroit meeting of the National Board of Boiler and Pressure Vessel Inspectors, which resulted in the formulation of valuable plans for bringing about the simplification of the stamping and registration of boilers, the examination and certification of inspectors, and the uniform interpretation of the Boiler Code. Provision was made for closer coöperation with the Boiler Code Committee of The American Society of Mechanical Engineers in the interpretation and revision of the Code and also as to tolerances in its enforcement.

LIBRARY NOTES AND BOOK REVIEWS

THE AIRPLANE. By Frederick Bedell. D. Van Nostrand Co., New York, 1920. Cloth, 6 × 9 in., 257 pp., frontispiece, diagrams, $3.

The first six chapters of this volume contain, in revised form, the material previously published under the titles Airplane Characteristics and The Air Propeller. Seven additional chapters discuss problems of flight, performance and stability. The author's aim has been to present a well-rounded introductory treatment simple in form, but reasonably complete and accurate.

AMERICAN LUBRICANTS FROM THE STANDPOINT OF THE CONSUMER. By L. B. Lockhart. Second edition, revised and enlarged. The Chemical Publishing Co., Easton, Pa., 1920. Cloth, 6 × 9 in., 341 pp., illus., tables, $4.

This book is offered to buyers and users of lubricants as an aid in the intelligent selection of oils and greases. It describes the various commercial lubricants, explains the laws of friction, the conditions met in lubricating various classes of machinery and the methods used to satisfy them. Methods for chemical and physical tests are given, and specifications for oils and other lubricants for a great variety of purposes.

ASPHALTS AND ALLIED SUBSTANCES. By Herbert Abraham. Second edition, corrected. D. Van Nostrand Company, New York, 1920. Cloth, 6 × 9 in., 608 pp., illus., diagrams, tables, $6.

This is a comprehensive treatise for makers, sellers and users of asphalts, tars, pitches and their products. It includes the methods used for testing and analyzing raw and manufactured products, information on blending and compounding mixtures, general information on the scope of the use of bituminous materials and on their limitations, and the principles underlying the use of bituminous products for structural purposes. Topics which have been adequately presented in other books have been purposely subordinated to those concerning which little has hitherto been published.

CAMS, ELEMENTARY AND ADVANCED. By Franklin De Ronde Furman. John Wiley & Sons, Inc., New York, 1921. Cloth, 6 × 9 in., 234 pp., diagrams, $3.

The first five sections of this book appeared previously under the title, Elementary Cams. To these sections three have been added, giving a further development of the subject. The elementary portion gives a classification, an arrangement and a general method of solution of the well-known cams, and also a series of cam factors for base curves in common use. The advanced portion includes the development or use of the logarithmic, cube, circular, tangential and involute base curves, and the establishment of cam factors for those which have general ones.

DIE KOMPRESSIONS-KALTEMASCHINE. By W. Koeniger. R. Oldenbourg, Munich and Berlin, 1921. Paper, 6 × 9 in., 204 pp., plates, tables, diagrams, 30 M.

This book is based on an extensive investigation of sulphurous-acid refrigerating machines by its author. New views resulted, which contribute to a solution of the question why the "wet" process of compression is less efficient than the "dry," and which also led to new methods for the calculation of refrigerating machines. The book is intended for students of the theory of these machines and for designers, and includes both sulphurous-acid and ammonia machines.

ELEMENTARY DYNAMICS; a Text-Book for Engineers. By J. W. Landon. University Press, Cambridge, 1920. Cloth, 5 × 7 in., 246 pp., diagrams, $3.25.

The author of this textbook believes that many of the beginner's difficulties in grasping the fundamental principles of dynamics arise from an overemphasis of mathematics. This difficulty he attempts to avoid by emphasizing the physical ideas, whose meaning he explains partly by definition and description, but mainly by worked examples in which formulas are avoided as far as possible.

ELEMENTS OF MECHANISM. By Peter Schwamb, Allyne L. Merrill and Walter H. James. Third edition. John Wiley & Sons, Inc., New York, 1921. Cloth, 6 × 9 in., 372 pp., diagrams, $3.50.

After sixteen years this textbook appears in a thoroughly revised and expanded edition, embodying the changes suggested by its use for instruction at the Massachusetts Institute of Technology and other colleges. It is intended to provide a systematic, clear, and practical presentation of the subject, suited to the amount of time usually devoted to it in college courses.

ERTRAGREICHSTER AUSBAU VON WASSERKRAFTEN. By Dr. Leiner. R. Oldenbourg, Munich and Berlin, 1920. Paper, 8 × 11 in., 111 pp., diagrams, 40 M.

The author examines the principles which serve as a guide in estimating the probable financial returns from the utilization of a water power; then he studies the most advantageous method of development, depending upon the constancy or intermittency of the power, the possibility of using reservoirs, and similar factors.

GAGE DESIGN AND GAGE MAKING. By Erik Oberg and Franklin D. Jones. First edition, first printing. The Industrial Press, New York, 1920. Cloth, 6 × 9 in., 310 pp., illus., diagrams, $3.

Much, the authors state, has been published on manufacturing practice, but comparatively little on the design and making of the gages used to control manufacturing processes and insure interchangeability in finished parts. Their book is intended to present the principles upon which gage design depends, and to describe the methods of manufacturing, measuring and testing gages.

HYDRO-ELECTRIC DEVELOPMENT. By J. W. Meares. Sir Isaac Pitman & Sons, Ltd. (Pitman's technical primer series.) 90 pp., front., illus., 4 × 6 in., boards, $1.

This little primer, based on the author's experience, aims to set down in logical order the points which require attention in the discovery, reconnaissance and final design of a hydroelectric scheme. It is confined strictly to the hydraulic aspect of the problem, omitting electrical questions and the practical details of plant construction.

KUGELLAGER UND WALZENLAGER IN THEORIE UND PRAXIS. By Paul Haupt. R. Oldenbourg, Munich and Berlin, 1920. Paper, 6 × 9 in., 199 pp., tables, diagrams, 18 M.

This work is a summary and extension of the scattered literature on bearings with rolling friction. Besides a theoretical discussion of the laws underlying the construction of ball and roller bearings, current practice is described, and the commercial types are examined critically.

PERSONAL RECOLLECTIONS OF ANDREW CARNEGIE. By Frederick Lynch. Fleming H. Revell Co., New York. Cloth, 6 × 8 in., 184 pp., portrait, $1.50.

Dr. Lynch's reminiscences cover a phase of Mr. Carnegie's activities that is not so widely known as his beneficences. His love of poetry and music, his religious opinions, interest in international peace, his views on education and similar topics, are set forth as he gave them to his friends.

PROPERTIES OF STEAM AND THERMODYNAMIC THEORY OF TURBINES. By H. L. Callendar. Longmans, Green & Co., New York, 1920. Cloth 6 × 9 in., 531 pp., diagrams, tables, $14.

This work gives a connected account of the conclusions resulting from the author's extended experimental and theoretical investigations of the problems depending primarily on the properties of steam. It is therefore intended to supplement treatises written from an engineering standpoint, by presenting the thermodynamical aspect of the problem. The book explains the origin of the author's equations for steam, shows how well his theory has fitted with subsequent work, and how his equations and tables may best be applied to more recent developments. A considerable portion deals with the thermodynamical theory of turbines, and here some new methods are introduced which the author believes will be useful to engineers. The book includes his steam tables.

THE ENGINEERING INDEX

(*Registered U. S. Patent Off.*)

THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press of particular interest to mechanical engineers. At the end of the year the monthly installments are combined along with items dealing with civil, electrical, mining and other branches of engineering, and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.

Photostatic copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents per page, plus postage. A separate print is required for each page of the larger periodicals, but wherever possible two small or medium-sized pages will be photographed together on the same print. The bill will be mailed with the print. When ordering photostats identify the article by quoting from the Index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication of periodical; (4) Page numbers. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.

ABRASIVE WHEELS

Manufacture. Manufacturing Abrasive Wheels. Eng. Production, vol. 2, no. 16, Jan. 20, 1921, pp. 82–88, 14 figs. Methods of Universal Grinding Wheel Co., England.

ACCIDENTS

Dust Explosions. Some Electrical Causes of Dust Explosions. David J. Price. Elec. Rev. (Chicago), vol. 78, no. 5, Jan. 29, 1921, pp. 179–181, 5 figs. Results of investigations of explosions and fires attributed to electricity at Bur. of Chemistry, U. S. Dept. of Agriculture. Menace of static electricity to grain threshing and cotton-mill operations.

The Cause and Prevention of Dust Explosions (Ueber die Entstehung von Staubexplosionen und ihre Verhütung). H. Weinmann. Zeit. für das Berg-, Hütten- u. Salinenwesen, vol. 68, no. 3, 1920, pp. 100–114, 2 figs. Results of investigations carried out by author to determine whether disastrous explosions which occurred in a German sugar factory were the result of pure sugar-dust explosions or of such explosions in conjunction with other gases.

AERONAUTICAL INSTRUMENTS

Speed Recorder. A Manometer for Recording Flight Speeds (Ein Manometer zur Aufzeichnung von Fluggeschwindigkeiten). C. Wieselsberger. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 12, no. 1, Jan. 15, 1921, pp. 4–6, 4 figs. Details of instrument constructed in the workshop of the Göttinger aerodynamic testing station, which is said to have shown good results in trial flights.

Two-Needle. Two-Needle Aeronautical Instruments (Appareils de bord à deux aiguilles). M. Dugit. Vie technique & industrielle, vol. 2, no. 16, Jan. 1921, pp. 323–327, 4 figs. Details of construction and uses in aerial navigation.

Uses. Aeronautic Instruments. Charles E. Mendenhall. Aerial Age, vol. 12, no. 20, Jan. 24, 1921, pp. 512–515, 5 figs. Classification of instruments and methods of using.

AEROPLANE ENGINES

Clearance-Volume Measurements. Instrument for Measuring Engine Clearance Volumes. S. W. Sparrow. Aerial Age, vol. 12, no. 23, Feb. 14, 1921, pp. 583–584, 6 figs. Instrument designed and constructed under direction of Automotive Power Plants Section of Bur. of Standards; Technical note of Nat. Advisory Committee for Aeronautics.

Near-Diesel. A Near-Diesel Engine for the Airplane. Harold F. Blanchard. Sci. Am., vol. 124, no. 4, Jan. 22, 1921, pp. 65 and 79, 3 figs. Engine designed by Prof. Junkers. Advantages claimed are low weight per horsepower, increased reliability, higher fuel economy, greater simplicity, safety against fire, and perfect balance.

Superchargers. Turbine-Driven Aeroplane Engine Superchargers for Flight at High Altitudes (Les surpresseurs pour moteurs d'aéroplanes à commande par turbine, pour le vol aux hautes altitudes). Génie Civil, vol. 78, no. 3, Jan. 15, 1921, pp. 55–56, 2 figs. Economical advantages of supercharging engine at high altitudes. Supercharger constructed by Gen. Elec. Co.

Wright. New Wright Aeronautic Engine Succeeds the Hispano-Suiza. A. Ludlow Clayden. Automotive Industries, vol. 44, no. 4, Jan. 27, 1921, pp. 154–156, 4 figs. Machine retains steel sleeve and combination valve stem and tappet, but embodies many changes originally developed by Wright Co., including better cooling and simplified lubrication systems. New magneto mounting provided.

Turbo-Compressors for. The Rateau Turbo-Compressor. H. M. Buckwald. Aviation, vol. 10, no. 3, Jan. 17, 1921, pp. 73–76, 10 figs. Details of construction and results of tests.

AEROPLANE PROPELLERS

All-Metal. The Leitner-Watts All-Metal Propeller. Aerial Age, vol. 12, no. 22, Feb. 7, 1921, pp. 559–560, 3 figs. Structural details, and records of tests.

Reversible Pitch. Hart Reversible Pitch Propeller. Aviation, vol. 10, no. 3, Jan. 17, 1921, pp. 79–80, 6 figs. Experiments of Engineering Division, U. S. Army Air Service.

Variable-Pitch. Parker Variable Pitch Air Screw, Billy Parker. Aerial Age, vol. 12, no. 24, Feb. 21, 1921, pp. 610–711, 2 figs. As machine climbs into higher altitudes and more rarified air is encountered, blades automatically increase their pitch so that constant load is kept on motor.

AEROPLANES

Aerofoils. See Wings.

Design. Aeronautics in 1920. I. Engr., vol. 131, no. 3393, Jan. 7, 1921, pp. 5–7, 9 figs. partly on 2 supp. plates. Survey of developments in aeroplane design.

Aeroplane Design. F. S. Barnwell. Aeronautics vol. 20, no. 379, Jan. 20, 1921, pp. 49–50. Table of airscrews of not more than 8 ft. diameter to absorb 1 hp. (Concluded.) Paper read before Cambridge University Aeronautical Soc.

Fuselage Construction. The Monocoque Fuselage. Lester D. Seymour. Aviation, vol. 10, no. 7, Feb. 14, 1921, pp. 203 and 206, 6 figs. Structural details of one-piece monocoque fuselage invented in France. Advantages of this type of construction.

Passenger. The 1000-Hp. Passenger Monoplane of the Zeppelin Works, Staaken (Das 1000 Ps-Verkehrsflugzeug der Zeppelin-Werke, Staaken). A. K. Rohrbach. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 12, no. 1, Jan. 15, 1921, pp. 1–4, 8 figs. Specifications: Engine, four 260 hp. Maybach engines; span, 31 m.; aerofoil surface, 106 sq. m.; gliding speed, 130 km. per hr.; carrying capacity, 18 passengers and 2 pilots; fuel-storage capacity, 6 hl. Duralumin is used for aerofoil, fuselage and empennage.

Stabilizers. The Automatic Control of Aeroplanes. Engineering, vol. 111, no. 2876, Feb. 11, 1921, pp. 178–179, 3 figs. Aveline automatic control apparatus for aeroplanes.

The Aveline "Automatic Pilot." Flight, vol. 13, no. 5, Feb. 3, 1921, pp. 73–75, 7 figs. Patented stabilizer employing inclinometer in which fluid is mercury. Machine is based on slight modifications of pendulum principle and is partly electric, partly pneumatic and partly aerodynamic.

Testing, Railway for. A Railway for Testing Full Size Aeroplanes. H. Bendemann. Aeronautics, vol. 20, no. 380, Jan. 27, 1921, pp. 64–65, 5 figs. Testing tower placed on modification of railway truck which is pulled along by locomotive. On top of tower is placed full-sized aeroplane to be tested. Paper read before German Aeronautical Soc.

Wings. A German Rival of the Handley-Page Wing. Aviation, vol. 10, no. 6, Feb. 7, 1921, p. 179, 1 fig. Wing with peculiarly shaped passages which are said to increase both pressure on under side and suction on upper side. Translated from Flugsport.

The Action of Aeroplane Wings (Die Wirkungsweise der Tragflächen). H. Lorenz. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 1, Jan. 1, 1921, pp. 8–11, 9 figs. Deals with pressure of wings, and the influence of inclination and camber suface.

The Glenn Martin High-Lift Wing. Aerial Age, vol. 12, no. 23, Feb. 14, 1921, p. 585, 1 fig. It is said that Glenn Martin Co. of Cleveland have designed aeroplane wing which can lift greater weight per sq. ft. than any other known type. No description of wing is given.

The Internally Trussed Wing. William B. Stout. Aviation, vol. 10, no. 7, Feb. 14, 1921, p. 200. Comparative study of American and German designs.

The Lachmann Aerofoil. Aerial Age, vol. 12, no. 22, Feb. 7, 1921, p. 560, 2 figs. German design consisting of several separate staggered elements arranged in form of Venetian blind. Translated from Flugsport.

Torsion of Wing Trusses at Diving Speeds. Roy G. Miller. Nat. Advisory Committee for Aeronautics, report no. 104, 1920, 8 pp. 4 figs. Suggestions in regard to methods for analyzing stresses in wing truss in vertical dive at limiting velocity.

[See also SEAPLANES; WIND TUNNELS.]

AIR COMPRESSORS

Membrane. The Membrane Compressor (Compresseur à membrane). H. Corblin. Comptes rendus des Seances de l'Academie des Sciences, vol. 172, no. 1, Jan. 3, 1921, pp. 46–48, 1 fig. Air or gas is compressed by alternative movements of circular membrane held rigidly at edges between two conically shaped hollow disks. Above one of these disks a piston forces air or liquid into and out of disk. Air is compressed by movements of membrane operating suitable valves in other disk.

AIR FILTERS

Radio Type. Air Filters (Luftfilter). K. Reichardt. Oel- u. Gasmaschine, vol. 17, no. 12, Dec. 1920, pp. 185–186, 2 figs. Describes the Radio air filter equipped with a chamber in which the admitted air is conducted over a large perforated surface and distributed, after which it passes into the filter proper which is filled with metal rings having lateral openings. The dust-absorbing capacity of filter is said to be much greater than that of cloth or wire filters.

AIR SERVICE, UNITED STATES

United Air Force. United Air Force—Pro and Con. Aviation, vol. 10, no. 7, Feb. 14, 1921, pp. 196–198. Arguments for and against army and navy united air force. (Concluded.)

AIRCRAFT

Anchorage. The Universal Aircraft Anchorage. Flying, vol. 10, no. 1, Feb. 1921, pp. 22–24, 5 figs.

Copyright 1921, by THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

NOTE.—The abbreviations used in indexing are as follows:

Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

Dock for landing, mooring and storing of airships and aeroplane, invented by E. S. Ullman.

Submarine vs. Aircraft v. Submarines, L. H. Strain. Flight, vol. 13, no. 3, Jan. 20, 1921, pp. 46–48. Their comparative value as weapons of war studied from records of their respective applications in last war. Writer believes that if air force is developed extensively there need not be any fear of the submarine in future campaigns. Paper read before Royal Aeronautical Soc.

AIRCRAFT CONSTRUCTION MATERIALS

Plywood. See PLYWOOD.

Steels. British Standard Schedule of Cold Worked Steels for Aircraft. British Eng. Standards Assn., no. 112, Nov. 1920, 15 pp., 2 figs. Schedule of seven cold-worked steels in form of black bars. Chemical composition, heat treatment and mechanical properties are specified.

British Standard Schedule of Sheet Steels for Aircraft. British Eng. Standards Assn., no. 113, Nov. 1920, 12 pp., 3 figs. Schedule of three sheet steels. Chemical composition, heat treatment and mechanical properties are specified.

British Standard Schedule of Valve and Valve Spring Steels for Aircraft. British Eng. Standards Assn., no. 114, Nov. 1920, 17 pp., 7 figs. Schedule of three valve steels and two valve-spring steels for aircraft engines. Chemical composition, heat treatment and mechanical properties are specified for steel in form of bars, forgings and drop forgings.

British Standard Schedule of Wrought Steels for Aircraft. British Eng. Standards Assn., no. 111, Nov. 1920, 27 pp., 9 figs. Schedule of fourteen wrought steels in form of bars, billets, forgings and drop forgings. Chemical composition, heat treatment and mechanical properties are specified.

AIRSHIPS.

Rigid. Speed and Endurance of the Rigid Airship, E. H. Lewitt. Aeronautics, vol. 20, no. 379, Jan. 20, 1921, pp. 43–44, 2 figs. Graphs showing variation between speed, horsepower and capacity. (To be continued.)

Zeppelin. The Zeppelin Airships, L. 64 and L. 71, George Whale. Aeronautics, vol. 20, no. 377, Jan. 6, 1921, p. 9. Classification and description of types.

ALCOHOL

Peat as Source of. See PEAT, Gasoline from.

[See also AUTOMOBILE FUELS, Alcohol.]

ALLOY STEELS

Electrometric Analyses. The Electrometric Analyses of Special Steels (Analyses électrométriques des aciers spéciaux). Industrie Electrique, vol. 30, no. 686, Jan. 25, 1921, pp. 33–36, 5 figs. Industrial apparatus for determining chromium, vanadium, and manganese.

Uranium Steel. Investigates Uranium Alloy Steel, E. Polushkin. Iron Trade Rev., vol. 68, no. 6, Feb. 10, 1921, pp. 413–417, 6 figs. In medium-carbon steel uranium increases elastic limit and resistance to rupture without affecting ductility. No unusual results were obtained than could not be had with other special steels. Translated from Revue de Métallurgie.

ALUMINUM

Castings. Analyze Loss in Aluminum Shops—IV, Robert J. Anderson. Foundry, vol. 49, no. 3, Feb. 1, 1921, pp. 104–111. Tables showing casting losses in various foundries on different castings. Percentages of losses from enumerated causes are indicated in case and comparisons are made.

ALUMINUM ALLOYS

Aluminum-Iron. Influence of Iron on the Mechanical Properties of Chemical Aluminum (L'influence du fer sur les propriétés méchaniques de l'aluminium brut de coulée). Léon Guillet and Albert Portvin. Revue de Métallurgie, vol. 17, no. 11, Nov. 1920, pp. 753–756, 4 figs. Addition of iron to chemical aluminum was found to increase hardening and to diminish ductility. With 4 per cent iron alloy is not capable of plastic deformation.

Castings. Castings of Light Aluminum Alloys, Robert J. Anderson. Iron Age, vol. 107, no. 7, Feb. 17, 1921, pp. 433–436, 15 figs. Value of macroscopic examination in foundry practice. Its correlation with microstructure. Methods used and typical structures.

Copper-Aluminum. Mechanism of Solidification of a Copper-Aluminum Alloy, Junius David Edwards. Chem. & Metallurgical Eng., vol. 24, no. 5, Feb. 2, 1921, pp. 217–220, 5 figs. Study of piping, segregation and mechanism of solidification of Cu-Al alloys, especially no. 12 containing 8 per cent aluminum, by means of precision measurements on density at various high temperatures.

AMMONIA

Manufacture. Artificial Ammonia, Jacques Boyer. Sci. Am., vol. 124, no. 6, Feb. 5, 1921, pp. 110, 4 figs. Claude process in successful operation in France.

British Neutral Sulphate Process, E. V. Evans. Gas Age, vol. 47, no. 2, Jan. 25, 1921, pp. 44–46. Methods of neutralizing free acid by ammonia gas at South Metropolitan Gas Co., London. Paper read before Southern District Assn. of Gas Engrs. & Managers.

Saturated, Tables for. Temperature and Pressure Tables for Saturated Ammonia. Power, vol. 53, no. 3, Jan. 18, 1921, pp. 96–99. Tentative tables prepared by U. S. Bur. of Standards.

Synthetic. Manufacture of Synthetic Ammonia at Oppau, Germany—I. Chem. & Metallurgical Eng., vol. 24, no. 7, Feb. 16, 1921, pp. 305–308, 7 figs. Principle of process. Manufacture of producer gas and water gas used in process. Purification of gas mixture. Catalytic oxidation of carbon monoxide. Elimination of carbon dioxide and carbon monoxide. Translated from Technique Moderne.

AMMONIA ABSORPTION REFRIGERATING SYSTEM

Non-Condensible Gases in. Causes and Prevention of the Formation of Noncondensible Gases in Ammonia Absorption Refrigeration Machines. E. C. McKelvy and Aaron Isaacs. Technologic Papers, Bur. of Standards, Dept. of Commerce, no. 180, Oct. 25, 1920, 10 pp., 1 fig. Method for quantitative estimation of carbon dioxide in ammonia is also given.

APPRENTICES, TRAINING OF

Draftsmen. How to Train Drafting Apprentices, S. E. Ferry. Indus. Management, vol. 61, no. 3, Feb. 1, 1921, pp. 95–97. Outline of two-year training course.

Methods. Programs of Apprenticeship and Special Training in Representative Corporations, J. V. L. Morris. Am. Mach., vol. 54, no. 6, Feb. 10, 1921, pp. 230–232, 4 figs. Practice of Brown & Sharpe Mfg. Co., Providence, R. I. Apprentice training has gone on for 70 years. Present school holds classes during working hours. Cooperative students also are employed.

Programs of Apprenticeship and Special Training in Representative Corporations, J. V. L. Morris. Am. Mach., vol. 54, no. 8, Feb. 24, 1921, pp. 310–312, 3 figs. Practice of Bethlehem Shipbuilding Corp., Quincy, Mass. Sub-foremen are trained to act as instructors for new men.

School Education. Engineering Education, Charles C. Garrard. Eng. Rev., vol. 34, no. 7, Jan. 1921, pp. 175–178 and 180. Report of City of Birmingham Education Committee on school education of apprentices.

Textile Mills. Standardized Training of Textile Apprentices, Eugene Scepesi. Textile World, vol. 59, no. 6, Feb. 5, 1921, pp. 193 and 295, 298, 305 and 309, 10 figs. Uniform methods of industrial education, a means for reducing waste and loss accruing under present system.

AUTOMOBILE ENGINES

Abell. A High Speed Engine with Positively Operated Valves. Automotive Industries, vol. 44, no. 4, Jan. 27, 1921, pp. 157–159, 4 figs. Abell design in which but one poppet valve per cylinder is used, this being put in communication alternately with inlet and exhaust ports by rotary distributor placed lengthwise of cylinder head casting. Yoked rocker levers have two rollers in contact with opposit sides of cam. Cooling of valves by incoming charge makes it possible to use higher compression without knock.

Air-Cooled. A Revolving Air-Cooled Engine. Automotive Industries, vol. 44, no. 5, Feb. 3, 1921, pp. 219–220, 1 fig. Has cylinder axes parallel to axis of rotation and utilizes wobbling-plate principle. Is of four cycle type but has planetary gear so arranged that engine makes one revolution for two revolutions of plate, thus combining high piston speed with low rotative speed. Single sleeve valve of cast iron is employed in each of five aluminum cylinders.

Air-Temperature Regulation. Air-Temperature Regulation Effects on Fuel Economy, Reuben E. Fielder. Jl. Soc. Automotive Engrs., vol. 8, no. 2, Feb. 1921, pp. 119–122, 7 figs. Tests conducted by Fifth Avenue Coach Co. of New York City to study temperature of air entering into cylinder.

Carburetors. See CARBURETORS.

Design. Fuel Problem in Relation to Engineering Viewpoint, A. L. Nelson. Jl. Soc. Automotive Engrs., vol. 8, no. 2, Feb. 1921, pp. 101–115, 33 figs. Account of extensive tests conducted with view of studying effect of engine design and correlation of results obtained for undertaking research of fuel problem.

Relation Between Principal Characteristics of an Automobile Engine (Relations entre les principales données constructives d'un moteur), Raymond Bricout. Technique automobile et aérienne, vol. 11, no. 111, 1920, p. 127, 1 fig. Graphs showing relation between cylinder diameter, piston stroke r.p.m., etc.

Eight-Cylinder, Balancing. Balancing of Eight-Cylinder Automobile Engine, and Order of Firing of Cylinders (Etude du moteur à huit cylindres en ligne au point de vue équilibrage et ordre du travail des cylindres). Technique automobile et aérienne, vol. 11, no. 111, 1920, pp. 97–125, 31 figs. Diagrams indicating stresses in crankshaft at various stages of rotation, computation of maxima stresses formulas for inertia forces, etc.

Engine Speed and Air Speed. Diagram Giving the Velocity of an Automobile in Terms of the R.P.M. of a Motor (Abaque donnant la vitesse d'une voiture en fonction de la vitesse de rotation du moteur), R. Bricout. Technique automobile et aérienne, vol. 11, no. 111, 1920, p. 126, 1 fig.

Hot-Spot Manifold. The Volatility of Internal-Combustion Engine Gasoline, Frank A. Howard. Jl. Soc. Automotive Engrs., vol. 8, no. 2, Feb. 1921, pp. 145–148, 1 fig. Argument for further development, improvement and wider use of hot-spot manifold of automotive engines.

AUTOMOBILE FUELS

Alcohol. Researches on Alcohol as a Fuel for Internal Combustion Engines. Harold B. Dixon. Automotive Industries, vol. 44, no. 5, Feb. 3, 1921, pp. 211–215. Basic data on vapor pressure, ignition temperature, movement of flame through explosive mixtures and detonation of vapor of alcohol, gasoline, benzol and various mixtures of two of these fuels. Authorization of standard alcohol mixtures to be used with present engines is urged.

Naphthalene. The Combustion of Naphthalene Solutions in Internal Combustion Engines, L. S. Palmer. Automobile Engr., vol. 11, no. 146, Jan. 1921, pp. 31–34, 6 figs. Naphthalene dissolved in benzole to strength of 15 per cent by weight said to form efficient fuel for ordinary gasoline engines.

Research. Notes on Current Fuel Research. Jl. Soc. Automotive Engrs., vol. 8, no. 2, Feb. 1921, pp. 131–134. Answers to circular letters sent to members of Soc. of Automotive Engrs., asking them method in which they were studying fuel problm and reasons for policy followed in their studies.

AUTOMOBILE INDUSTRY

Germany. The German Automobile and Aircraft Industries, Automobile Engr., vol. 11, no. 146, Jan. 1921, pp. 25–27. There have been no changes in principal designs. In contrast with England, France and Italy there is absence of Americanization in chassis design and construction.

AUTOMOBILES

American-Made. 1921 Passenger Automobiles Listed with Their Technical Specifications. Motor Age, vol. 39, no. 4, Jan. 27, 1921, pp. 78–81. Tabulated data of American-made automobiles with makes of principal parts, including engine, lubrication and ignition systems, etc.

Battery Charging. Electric Vehicle Charging Equipments, E. Austin. Automobile Engr., vol. 11, no. 146, Jan. 1921, pp. 22–24, 6 figs. Machine built by Lancashire Dynamo & Motor Co. for working on polyphase circuit.

Body Construction. Some Sheet Metal Body Work. Am. Mach., vol. 54, no. 8, Feb. 24, 1921, pp. 318–320, 6 figs. Operations involved in making metal bodies for Ford cars. Blanking, forming and finishing sheets.

Body Design. Style in Automobile Bodies, George J. Mercer. Jl. Soc. Automotive Engrs., vol. 8, no. 2, Feb. 1921, pp. 123–126, 1 fig. Prevailing body types and possible developments.

Brakes. Friction Metal for Brake Linings. Automotive Industries, vol. 44, no. 4, Jan. 27, 1921, p. 153, 1 fig. Adaptation of European practice facilitated by manufacture in this country of copper-lead alloy said to possess exceptional friction qualities. Tests with V-shape brake on truck promise well. Elimination of brake squeaking said to be effected. High friction coefficient claimed.

Brussels Show. The Brussels Salon (Le salon de Bruxelles), H. Petit. Vie Automobile, vol. 16, no. 720, Dec. 25, 1920, pp. 476–481, 13 figs. Survey of exhibits. (To be continued.)

Chassis Design. Chassis Design for Fuel Economy, A. L. Putnam. Jl. Soc. Automotive Engrs., vol. 8, no. 2, Feb. 1921, pp. 167–168. Basis for research.

French. Automobile Production for 1921 (La production automobile pour 1921), Charle Faroux, Henri Petit and André Contet. Vie Automobile, vol. 16, no. 720, Dec. 25, 1920, pp. I-LXXIII, 120 figs. Particulars of types to be constructed during 1921 by leading French automobile works, including also projected designs of motorcycles and automobile accessories.

Friction Drive. Kelsey Friction-Driven Car is Announced. Automotive Manufacturer, vol 42, no. 10, Jan. 1921, pp. 26–29, 3 figs. Friction drive said to effect loss of 13 and 25 per cent on high and low speeds respectively, as compared to 25 and 30 per cent equivalent for average gear drive.

Gradient Meter. The Tapley Gradient Meter. Autocar, vol. 46, no. 1316, Jan. 8, 1921, p. 54, 2 figs. Needle indicates on gradient scale steepness of hill.

New York Show. Some New Parts Seen at the New York Show, P. M. Heldt. Automotive Industries, vol. 44, no. 4, Jan. 27, 1921, pp. 160–161, 5 figs. Two new axles, one of which uses two cone clutches in place of differential, are shown. New flexible universal of laminated steel, automatic advance magneto coupling, and lubricating system, for transmission universals and axle, are among developments.

Transmission Gears. Impact Stresses in the Transmission Gears of Automobiles (Sur les chocs dans les engrenages de changement de vitesse des automobiles), A. Petot. Comptes rendus des Séances de l'Académie des Sciences, vol. 172, no. 1, Jan. 3, 1921, pp. 42–44. Formulas for computing stresses.

AVIATION

City Ordinances. Aerial Ordinance for New York City. Flying, vol. 10, no. 1, Feb. 1921, p. 25. Ordinance governing air traffic over New York City.

Civil. Progress of British Civil Aviation. Aviation, vol. 10, no. 7, Feb. 14, 1921, pp. 207–208. Report of British Controller-General of Civil Aviation on progress of civil aviation covering six months period from April 1 to Sept. 30, 1920.

Commercial. European Recognition of the Possibilities of the Airplane for Commercial Uses, E. A. Dixie. Am. Mach., vol. 54, no. 6, Feb. 10, 1921, pp. 233–234, 2 figs. English daily papers publish meteorological reports. There are two lines of air buses between London and Paris.

The Design Requirements of Commercial Aviation, Grover C. Loening. Jl. Soc. Automotive Engrs., vol. 8, no. 2, Feb. 1921, pp. 135–144, 13 figs. Single-engined versus multi-engined planes. Desirable future developments.

Developments. Review of Aviation in 1920. Aviation, vol. 10, no. 3, Jan. 17, 1921, pp. 83–84. Prepared by Manufacturers' Aircraft Association.

Forest Fire Patrol. A Year of the Aerial Forest Fire Patrol. Flying, vol. 10, no. 1, Feb. 1921, pp. 13–16. Report submitted by air officer of headquarters ninth corps area at San Francisco.

B

BALANCING MACHINES

Turbine-Rotor. Martin's Rotor Balancing Machine. Elec. Rev. (Lond.), vol. 88, no. 2253, Jan. 28, 1921, pp. 101–102, 4 figs. Patented machine for balancing rotors without rotation.

BEARING METALS

Anti-Friction. Anti-Friction Bearing Metals. P. W. Priestley. Metal Industry (N. Y.), vol. 19, no. 2, Feb. 1921, pp. 66–67. Chemical, physical, and thermal review.

White-Metal. High-Temperature Properties of White-Metal Bearing Alloys. John R. Freeman, Jr. and R. W. Woodward. Jl. Soc. Automotive Engrs., vol. 8, no. 2, Feb. 1921, pp. 149–154 and 162, 8 figs. Preparation of alloys, and table of properties.

BELTING

Leather, Effect of Humidity on. Effect of Relative Humidity on Leather Belts. F. W. Roys. Can. Machy., vol. 25, no. 8, Feb. 3, 1921, pp. 76–78 and 98, 9 figs. Explanation of humidity, relative humidity, testing apparatus, atmospheric control, standard conditions and series of tests. Paper read before Nat. Assn. Leather Belting Manufacturers.

Rubber. Rubber in Mine and Mill. A. M. Oliver. Eng. & Min. Jl., vol. 111, no. 6, Feb. 5, 1921, pp. 258–262. 3 figs. Formulas for computing sizes and plies of belting.

BLAST FURNACES

Combustion Regulation. Regulation of the Combustion in Cupola Furnaces and of Working Process through Measurement of the Blast Capacities (Die Kontrolle der Verbrennung im Kuppelofen und des Arbeitsvorganges durch Windmengenmessung). H. Bansen. Stahl u. Eisen, vol. 41, no. 4, Jan. 27, 1921, pp. 114–115, 2 figs. Gives chart showing comparison of the analysis of flue gas taken from cupola furnace with the combustion curve of coke, and defines measurement of nozzle resistance.

Construction. New Blast Furnace Built at Midland. Blast Furnace & Steel Plant, vol. 9, no. 2, Feb. 1921, pp. 132–138, 1 fig. Construction of 600-ton furnace at Midland, Pa. Furnace stack is 92 ft. high with hearth 18 ft. diameter, stock line 16 ft. and bell 12 ft. diameter.

Developments in 1920. Blast Furnace Developments During 1920. Harvey W. Linhardt. Blast Furnace & Steel Plant, vol. 9, no. 1, Jan. 1921, pp. 20–22. Improvements in design, hot blast stoves, boiler plants, blowing engines, furnace appliances and gas cleaners.

Mechanical Equipment. Mechanical Equipment on Tapping Side of the Blast Furnace (Maschinenarbeit hinter dem Hochofen). F. W. Broy. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 3, Jan. 15, 1921, pp. 57–63, 15 figs. Calls attention to neglect up to present time of mechanical expedients on tapping side of blast furnace. Notes on difficult manual work on the casting beds insufficiency of the pig breakers; development of the pig hammers and charging cranes; high-capacity charging cranes; separation of the breaker and charging cranes. Diagrams showing utilization of the crane installation. Future problems.

Operation. Study of Coke Hardness, Owen R. Rice. Iron Trade Rev., vol. 68, no. 6, Feb. 10, 1921, pp. 423–426, 4 figs. Tests made in three stacks of Bethlehem Steel Co. to determine relation of furnace condition to coke hardness. (Abstract.) Paper read before Am. Inst. Min. & Metallurgical Engrs.

Sulphur Content of Charge. The Sulphur Content of an Iron Charge in Cupola-Furnace Melting Process with the First Tapping in Contrast to the Following (Der Schwefelgehalt einer Eisengattierung im Kupolofen-Schmelzprozess beim ersten Abstich gegenüber den folgenden). Paul Liebaldt. Giesserei-Zeitung, vol. 18, no. 1, Jan. 1, 1921, pp. 5–8. Tables giving results of a series of chemical and mechanical experimental investigations demonstrating that the first tapping does not show an enrichment of sulphur nor a greater silicon residue than the following. For special castings it is said to be advisable not to use the first tapping because in most cases it is too dull.

BLOWERS

Power Chart. Notes on the Calculation of Blower Systems. John L. Alden. Power, vol. 53, no. 5, Feb. 1, 1921, pp. 180–183, 2 figs. Power chart for air blowers, and friction chart for air piping.

BOILER EXPLOSIONS

Records. Forty Years of Boiler Explosions. Locomotive, vol. 33, no. 4, Oct. 1920, pp. 101–108, 8 figs. There have been in period 1880–1919 total of 14,281 explosions, 10,638 lives lost and 17,085 persons injured.

BOILER FEEDWATER

Treatment. Saving Money by Water Treatment. Paul M. LaBach. Ry. Maintenance Engr., vol. 17, no. 1, Jan. 1921, pp. 17–20, 3 figs. Water treating plants installed by Rock Island system, and results obtained.

BOILER OPERATION

Coal Saving. Coal-Saving in the Chemical Industry. David Brownlie. Pamphlet published by Brownlie & Green, England, 15 pp. Rules for scientific control of steam boiler plant based on records of performance of 60 typical steam boiler plants of chemical industry of Great Britain. Reprinted from Chem. Trade Jl. & Chem. Engr., Aug.-Sept. 1920.

Feedwater Regulation. Scientific Boiler Feed Water Regulation. Roland Moeller. Jl. Am. Soc. Heat & Vent. Engrs., vol. 27, no. 1, Jan. 1921, pp. 19–24, 6 figs. Automatic mechanical device.

Firing. Influence Upon Boiler Economy of Continuous Firing of Highly Volatile Fuel Without Intervening Cleaning. A. B. Reek. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 27, no. 1, Jan. 1921, pp. 1–5, 3 figs. Results of two tests with bituminous coal one made before and another after fourteen days of continuous firing with same fuel without intervening cleaning.

BOILERS

Bonecourt Gas-Fired. Recent Developments in Gas Firing Steam Boilers, and in the Utilization of Waste Heat, on the "Bonecourt" System. W. Gregson. Proc. South Wales Inst. Engrs., vol. 36, no. 2, Jan. 21, 1921, pp. 279–314 and (discussion) pp. 488–508, 13 figs. Bonecourt boiler consists essentially of outer shell, forming boiler, fitted with longitudinal fire-tubes which carries special packing, mixture of gas and air being drawn through boiler either by natural draught or by suitably arranged suction fan.

Holdsworth. The Holdsworth Lancashire and Yorkshire Boilers. Practical Engr., vol. 63, no. 1767, Jan. 6, 1921, pp. 8–11, 2 figs. Comparison of two types.

Inspection. A National System for the Inspection and Registration of Steam Boilers. Power, vol. 53, no. 2, Jan. 11, 1921, pp. 58–61. Plea for adoption by all States of Boiler Code of Am. Soc. Mech. Engrs., which was formulated by committee composed of representatives of users, designers and manufacturers of boilers and boiler materials after numerous and exhaustive hearings in which representatives of every interest affected took part. This Boiler Code has been adopted as standard by Boiler Inspection Departments of 17 states.

Körting Universal. A New Boiler Adaptable to Use of Different Kinds of Fuel (Ein neuer Heizkessel fur verschiedenartige Brennstoffe). Johannes Korting. Gesundheits-Ingenieur, vol. 43, no. 47, Nov. 20, 1920, pp. 584–586, 2 figs. Describes the Körting universal boiler for central heating constructed along lines of the cast-iron sectional boiler with the difference that the separate heating units are arranged, not back of, but alongside of each other. Its noteworthy features are pointed out and results of tests are given which confirm its feasibility.

Marine. See MARINE BOILERS.

Water Purification Chamber. Builds Water Purifier in Vertical Boiler. Iron Trade Rev., vol. 68, no. 4, Jan. 27, 1921, pp. 293, 1 fig. Locomotive crane boiler equipped with annular scale chamber placed between tubes and shell plate. Feedwater passes through scale chamber and attains temperature at which scale forming impurities are liberated from solution without chemicals.

BOILERS, WATER-TUBE

Mercantile Marine. Advantages of the Use of the Water-Tube Boiler in the Mercantile Marine. James Kemnal. North-East Coast Instn. of Engrs. & Shipbuilders, Advance paper, 9 pp. 8 figs. Advantages of water-tube boiler over cylindrical type.

BORING MACHINES

Horizontal. Recent Machine Tool Developments. Engineering, vol. 111, no. 2873, Jan. 21, 1921, pp. 66–69, 25 figs. partly on supp. plate. Horizontal boring machines.

BRAKES

Kunze-Knorr. The Standardization of Railroad Brakes (Zur Frage einer einheitlichen Eisenbahn-Bremse), C. Wetzel. Schweizerische Bauzeitung, vol. 77, no. 3, Jan. 13, 1921, pp. 29–33, 5 figs. Contains abstract of pamphlet describing and illustrating the Kunze-Knorr brake for freight trains. It is claimed that the Kunze-Knorr brake fulfills conditions required of a continuous freight-train brake as set up by the International Commission in 1909.

Shoe Design. Designing Brake Heads for Uniform Shoe Wear. H. M. P. Murphy. Ry. Mech. Engr., vol. 95, no. 2, Feb. 1921, pp. 107–108, 5 figs. Principle applicable to heads used on wheels revolving in one or both directions.

BRASS

Nickel. Nickel Brasses. Chem. & Mettallurgical Eng., vol. 24, no. 6, Feb. 9, 1921, pp. 261–265, 6 figs. Summary of work of Leon Guillet published in "Revue de Metallurgie" of 1913 and 1920 on important role played by nickel in manufacture of low-copper ternary brasses.

Ternary. Ternary Brasses. Chem. & Metallurgical Eng., vol. 24, no. 4, Jan. 26, 1921, pp. 177–178, 4 figs. Mathematical study of equilibrium diagram, and results of studies made by various investigators, notably L. Guillet in Revue de Métallurgie.

BROACHES

Manufacture. The Design and Manufacture of Broaches. Eng. Production, vol. 2, no. 17, Jan. 27, 1921, pp. 122–126, 3 figs. With special reference to parts having internal splines.

BUILDING CONSTRUCTION

Structural-Steel Standards. Construction Practice (Aus der Konstruktionspraxis), Rud. Kramer. Eisenbau, vol. 12, no. 1, Jan. 18, 1921, pp. 7–18, 10 figs. Writer points to the absence of generally applicable standards in structural steelwork and presents, as result of experience, tables for rivet diameters, distances from center of rivet to outside of angle, distances of rivet from edge of plate, pitch of rivets, lengths of angles, etc.

BUILDINGS

Steel-Frame. See ELECTRIC WELDING, Steel-Frame Buildings.

C

CAR AXLES

Design. Notes on Axle Design. Machy. (Lond.), vol. 17, no. 434, Jan. 20, 1921, pp. 494–495, 3 figs. Chart for determining centrifugal force exerted on car axles when turning a curve.

CAR WHEELS

Chilled-Iron. Chilled-Iron Car-Wheels—Their Manufacture, Properties and Uses (Les roues en fonte trempée leur fabrication, propriétés et usages). M. E. Polushkin. Revue de Métallurgie, vol. 17, no. 11, Nov. 1920, pp. 713–735, 20 figs. European and American practices contrasted. (To be continued.)

CARBURETORS

Asmo. Some Carburation Points, and a New Carburettor—The Asmo. Auto-Motor Jl., vol. 26, no. 2, Jan. 13, 1921, pp. 41–42, 5 figs. Instrument incorporates vacuum-feed fuel-supply.

Kerosene. The "Caserator." Auto-Motor Jl., vol. 26, no. 1, Jan. 6, 1921, p. 20, 1 fig. Application of vaporization system of carbureting kerosene, especially for variable speeds of automobile conditions.

Reatomizing Device. A Re-Atomizing Device. Automotive Industries, vol. 44, no. 4, Jan. 27, 1921, p. 159, 1 fig. Spacer into which is pressed venturi throat carrying four small tubes is placed between carburetor and manifold. Ejector effect on four tubes which extend into throat tends to draw into annulus any liquid gasoline which may be passing up wall of carburetor and to eject it from tubes in atomized condition.

CARS

Container. Container Car in Express Service on N. Y. C. Lines. Ry. Age, vol. 70, no. 5, Feb. 4, 1921, pp. 315–316, 4 figs. Experimental car operated between New York and Chicago by Am. Ry. Express Co. Car is nine-section express car, its sectional cargo space consisting of nine separate containers or steel boxes firmly secured on car to prevent shifting during train movement.

CASE-HARDENING

Bibliography. Review of Case Carbonizing, 1920. O. A. Knight. Forging & Heat Treating, vol. 7, no. 1, Jan. 1921, pp. 51–54 and 65. Review and synopsis of important articles relative to case carbonizing which have appeared in current technical journals during past year.

Nitrogen and. Nitrogen and Case-Hardening. Henry Fay. Chem. & Metallurgical Eng., vol. 24, no. 7, Feb. 16, 1921, pp. 289–290. Nitrogenizing process which takes place when steel is heated in cyanide.

Steel. A New Method of Case Hardening Steel. William J. Merten. Trans. Am. Soc. for Steel Treating, vol. 1, no. 4, Jan. 1921, pp. 270–273, 1 fig. Heated steel is brought into contact with pure nascent gas continuously generated in separate unit, preferably under pressure.

CAST IRON

Briquetting Refuse. The "Boreas" Cast-Iron Refuse Briquetting Machine. Foundry Trade Jl., vol. 23, no. 229, Jan. 6, 1921, p. 20, 1 fig. Manufactured by Colley Engineering & Machinery Co., London, England.

CEMENT

Bauxite. Cast Cements and the Electric Furnace. M. J. Bied. Practical Engr., vol. 63, no. 1767, Jan. 6, 1921, pp. 6–7, 2 figs. Strength of bauxite cement. Translated from Revue de l'Ingenieur et Index Technique.

CEMENT, PORTLAND

"Marque Speciale." "Marque Speciale" Swiss Cement. Cement & Eng. News, vol. 33, no. 2, Feb. 1921, pp. 30–32. Portland cement with properties for developing early strength.

CENTRAL STATIONS

Economical Developments. Policies for Future Power Development. John Price Jackson. Mech. Eng., vol. 43, no. 2, Feb. 1921, pp. 102–106 and (discussion) pp. 106–107, and 110. Demand for central-station electric power in U. S. is contrasted with situation in England, and physical, public and financial relationships that are essential for relieving present stress and meeting that demand with reasonable economy and conservation of natural resources and labor are set forth.

France. Project of Departmental Distribution of Electrical Energy in Savoie (Projet de reseau départemental de distribution d'énergie électrique en Savoie). Revue générale de l'Electricité, vol. 9, no. 5, Jan. 29, 1921, pp. 147–150, 1 fig. Project for construction of central electric station in French department.

New York Metropolitan District. Heat, Light and Power for the Metropolitan District of New York.

William Barclay Parsons. Power, vol. 53, no. 8, Feb. 22, 1921, pp. 324–326. Economical advantages of constructing central station to supply needs of district. Total installation in district amounted in 1919 to 2,100,000 hp. and it is expected this will increase in 1930 to 4,500,000 hp.

Operation. Operation of Electric Central Stations (Etude des conditions de fonctionnement des centrales électriques), G. Jochmans. Société Belge des Electriciens, vol. 34, Nov.–Dec. 1920, pp. 261–273, 6 figs. Construction of load diagram. (To be continued.)

CHAINS

Testing. Chains and Lifting Gear. Mech. World, vol. 69, no. 1776, Jan. 14, 1921, pp. 36–37. Proving and testing. (Abstract.) Home Office pamphlet, of H. M. Stationery Office, Imperial House, London.

CHUCKS

Magnetic. Magnetic Chucks, Ellsworth Sheldon. Am. Mach., vol. 54, nos. 4 and 5, Jan. 27 and Feb. 3, 1921, pp. 121–124 and 7 figs., 177–180, 8 figs. Principle of operation and structural details of various types; classification of magnetic chucks.

Magnetic Chucks—II. Am. Mach., vol. 54, Nos. 6, 7 and 8, Feb. 10, 17 and 24, 1921, pp. 213–217, 8 figs., 265–269, 14 figs., and 324–329, 12 figs. Feb. 10: History of developments. First magnetic chuck patent issued 48 years ago. Early chucks and their construction. Progress from 1873 to 1914. Feb. 17: Characteristics of various types. Feb. 24: Downes, Patton and Walker types.

CLUTCHES

Ring. The Design of Expanding Ring Clutches, W. A. Milnes. Mech. World, vol. 69, no. 1776, Jan. 14, 1921, pp. 25–26, 4 figs. Computation of dimensions.

COAL

Briquetting. Anthracite Conservation by Briquetting, A. L. Stillman. Coal Industry, vol. 4, no. 2, Feb. 1921, pp. 100–103, 4 figs. Description of briquetting plant.

Distillation. By-Products of Coal Distillation (L'extraction des différents produits de la distillation de la houille), A. Grebel. Génie Civil, vol. 78, no. 2, Jan. 8, 1921, pp. 35–37, 2 figs. Processes and installation of Commentry-Fourchambault et Decazeville Society.

Recovery from Ashes. Fuel Recovery from Ashes. Eng. Production, vol. 2, no. 16, Jan. 20, 1921, p. 99, 1 fig. Typical plant in operation in French works for recovery from ashes unburnt coal in form of coke breeze.

COAL BREAKERS

Concentrating Tables. New Methods are Used for Preparing Small Sizes by Locust Mountain Coal Co., Dever C. Ashmead. Coal Age, vol. 19, no. 4, Jan. 27, 1921, pp. 171–179, 16 figs. At Weston Colliery Breaker sizes below pea are cleaned by concentrating tables and specially designed jig.

COAL HANDLING

Government Yard. How Uncle Sam Handles Coal at Washington, Frederick G. Cottrell. Coal Trade Jl., vol. 52, nos. 4 and 5, Jan. 26 and Feb. 2, 1921, pp. 113–115, 2 figs. and 142–144, 5 figs., Jan. 26: Layout of government yard which delivered 193,278 gross tons to various departments during past fiscal year. Feb. 2: Bin construction for loading of trucks.

Pipe Lines. Pumping Coal from Mine to Seaboard, C. H. Thomas. Sci. Am., vol. 124, no. 7, Feb. 12, 1921, pp. 121, 126 and 139, 7 figs. Scheme for shipping coal through pipe lines.

Scraper Loading. Costs of Scraper Loading and Conditions Under Which It Works Best, A. B. Benedict. Coal Age, vol. 19, no. 5, Feb. 3, 1921, pp. 222–226, 4 figs. Where coal is clean, faces fairly long, top good and above all where cars can be supplied regularly and in adequate number, scraper loader has successfully met widely varying conditions.

COAL MINES

Bituminous, Fire Prevention in. Causes and Prevention of Fires and Explosions in Bituminous Coal Mines, Edward Steidle. Dept. of Interior, Bur. of Mines, Miners' Circular 27, 1920, 75 pp. 117 figs. List of common causes of fires and explosions, prepared from examination of report of State Mine Dept. and of Bur. of Mines.

Electricity in. State Mining Laws on the Use of Electricity in and about Coal Mines, L. C. Ilsley. Dept. of Interior, Bur. of Mines, technical paper 271, 1920, 53 pp., 1 fig. 28 states have regulations prepared by commissions or enacted laws governing operation of coal mines.

COAL TAR

Research. Coal-Tar Research at Shadyside, John Morris Weiss and Charles Raymond Downs. Chem. & Metallurgical Eng., vol. 24, no. 4, Jan. 26, 1921, pp. 150–155, 6 figs. Account of expansion of scope and facilities of research department of Barrett Co. Study of physical properties, methods of testing and development of synthetic products.

COAL WASHING

Experimental Station. Coal Washing at the Northwest Experimental Station, Earl R. McMillan. Elec. Rev. (Chicago), vol. 78, no. 4, Jan. 22, 1921, pp. 142–145, 2 figs. Bur. of Mines plant prepared to recover 150,000 tons of culm in one dump

COKE

Hardness Testing. Importance of Hardness of Blast Furnace Coke, Owen R. Rice. Iron Age, vol. 107, no. 6, Feb. 10, 1921, pp. 380–381, 1 fig. Apparatus used at Bethlehem Steel Co. to determine hardness of coke. (Abstract.) Paper read before Am. Inst. Min. & Metallurgical Engrs.

COKE MANUFACTURE

Demster-Toogood Retorts. Demster-Toogood Continuous Verticals at Hawick. Gas World, vol. 74, no. 1905, Jan. 22, 1921, pp. 64–66, 2 figs. Demster-Toogood patented coking retort.

COKE-OVEN GAS

Composition. Composition of Coke-Oven Gases (Sur la composition de quelques gaz de fours à coke), P. Lebeau and A. Damienn. Comptes rendus des séances de l'académie des Sciences, vol. 171, no. 26, Dec. 27, 1920, pp. 1385–1386. Records of examinations.

COKE OVENS

By-Product. By-Product Coke Oven Plants of Yesterday and Today, J. M. Hastings, Jr. Blast Furnace & Steel Plant, vol. 9, no. 1, Jan. 1921, pp. 10–13, 6 figs. Progress of art in 28 years as illustrated by old and new plants of Semet-Solvay Co. Despite improvements original characteristics still remain.

Jones & Laughlin New By-Products Plant. Blast Furnace & Steel Plant, vol. 9, no. 1, Jan. 1921, pp. 13–17, 1 fig. Plant consists of five batteries of by-product ovens, each battery having 60 ovens of Koppers crossed regenerative type.

The By-Product Coke Oven Industry, 1920, C. J. Ramsburg. Blast Furnace & Steel Plant, vol. 9, no. 1, Jan. 1921, p. 18. First large battery of triangular-flue-type ovens completed and successfully operated during year. Special construction features of installations of year.

COMPRESSED AIR

Metering. The Metering of Compressed Air, John L. Hodgson. Colliery Guardian, vol. 121, no. 3135, Jan. 28, 1921, pp. 271–272, 10 figs. Types of meters in use. Paper read before Midland Inst. Min., Civil & Mech. Engrs.

CONCRETE

Porous. Secrets of Porete Manufacture, Ernest Walter. Tech. Eng. News, vol. 1, no. 10, Feb. 1921, pp. 5 and 12, 3 figs. Naphthalene or paraffin is mixed with cement in ordinary mixer and mixture poured into moulds of any desired shape. After setting for 24 hrs. slabs are removed and put into large tank to which steam is applied. Chemical melts slowly out of mixture.

Specifications. Some Controversal Points in Concrete Specifications, Frank Barber, Jl. Eng. Inst. of Canada, vol. 4, no. 2, Feb. 1921, pp. 117–122. Discussion on difficulties in preparing concrete specifications, with particular reference to provision of greater detail in clauses dealing with workmanship.

Strength. How Quantity of Mixing Water Affects Strength of Concrete. Eng. World, vol. 18, no. 2, Feb. 1921, pp. 95, 1 fig. Diagram constructed from tests made at Structural Material Research Laboratory, Lewis Inst., Chicago. Rule derived is to use smallest quantity of mixing water that will produce workable mix.

Tannic Acid, Effect on. Effect of Tannic Acid on the Strength of Concrete, Duff A. Abrams. Structural Matls. Research Laboratory, Lewis Inst., bul. 7, Nov. 1920, 31 pp., 16 figs. Tests conducted under auspices of Am. Soc. for Testing Matls. Strength of concrete was reduced for all percentages of tannic acid, for all mixes and ages used. Less than 0.1 per cent of tannic acid in terms of weight of aggregate may reduce strength of concrete to one-half its normal value. Reprinted from Proc. Am. Soc. for Testing Matls.

CONCRETE CONSTRUCTION

Costs. On the Economics of Building Design, J. Morrow Oxley. Jl. Eng. Inst. of Canada, vol. 4, no. 2, Feb. 1921; pp. 123–130, 8 figs. Graphs and tables showing relative effect on cost of variations in proportions, dimensions and floor loading for standard types of buildings.

Hessian System. The Hessian Fabric System of Concrete Construction. Concrete & Constructional Eng., vol. 16, no. 1, Jan. 1921, pp. 62–64, 3 figs. Walls are erected in situ by means of wooden molds which are raised course by course until wall is completed.

Stresses. Latest Developments in Concrete, H. C. Boyden. Nebraska Blue-Print, vol. 19, no. 4, May 1920, pp. 72–85. Survey of researches on stresses of concrete structures, and of laws which have been formulated for designing them.

CONCRETE, REINFORCED

Bond in. Bond in Reinforced Concrete. Engr. vol. 131, no. 3395, Jan. 21, 1921, pp. 65–66. Results of tests in which bars were pushed through prisms of concrete. Comparison with tests in which bars were pulled out.

Slabs. The Strength of Reinforced-Concrete Slabs with Cross-Reinforcement (Krydsarmerede Jærnbetonpladers Styrke), N. J. Nielsen. Ingeniören, vol. 29, no. 94, Nov. 24, 1920, pp. 723–728, 8 figs. It is shown that the ultimate stresses in reinforced-concrete can be calculated by means of differential equations. Numerical examples for square and rectangular plates.

Stress Formula. Formula for Computing Compressive Stress that can be Borne by Reinforced Concrete (Formule rationnelle du taux de compression du béton), M. Mougnié. Annales des Ponts et Chaussées, vol. 5, no. 10, Sept.-Oct. 1920, pp. 142–154. Formula involving coefficient which is ratio of theoretical moduli of elasticity of steel and concrete.

CONTRACTORS

Code of Ethics. Proposed Code of Ethics for Contractors. Eng. News-Rec., vol. 86, no. 6, Feb. 10, 1921, pp. 257–258. Submitted at New Orleans convention for consideration of the members of Associated General Contractors.

CORE OVENS

Electric. Electric Heating in the Iron Industry, Wirt S. Scott. Iron Age, vol. 107, no. 6, Feb. 10, 1921, pp. 384–385. Development of electric core ovens for foundry and experiences with heat treating furnaces.

COST ACCOUNTING

Power Plants. Armour System of Power Plant Accounting—II, O. A. Anderson. Power, vol. 53, no. 5, Feb. 1, 1921, pp. 170–174, 11 figs. Report system supplemented by charts and table to eliminate calculations.

CRANES

Control Apparatus. The Bergmann System of Control of Crane Hoisting Gear (Steuerung von Kranhubwerken, System Bergmann), Ernst Blau. Elektrotechnik u. Maschinenbau, vol. 39, no. 3, Jan. 16, 1921, pp. 29–31, 1 fig. Describes arrangement and operation of control apparatus developed by the Bergmann Electrical Works, Berlin, with which it is possible to effect a speed range from 1 to 60, and which has given satisfactory service in workshops, foundries, steelworks, etc.

Floating. Self-Propelled Floating Crane. Steamship, vol. 32, no. 379, Jan. 1921, pp. 177–178, 1 fig. 200-ton floating crane at Mersey Docks and Harbour Board, Liverpool.

CRANKSHAFTS

Crankpin Turning Machine. Rotating-Tool Crank Pin Turning Machine. Engr., vol. 131, no. 3396, Jan. 28, 1921, pp. 102–103, 3 figs. Machine belongs to class in which crankshaft is held stationary while tools for turning up pins and inside surfaces of webs are carried in revolving slide. Manufactured by George Richards & Co., England.

D

DIE CASTINGS

Uses. Application of Inserts to Die Castings, M. Stern. Am. Mach., vol. 54, no. 7, Feb. 17, 1921, pp. 284–286, 9 figs. Division of application of inserts into four general groups. Various methods of providing inserts with anchors. Locating points.

DIES

Manufacture. A School for Die Sinkers, J. H. G. Williams. Forging & Heat Treating, vol. 7, no. 1, Jan. 1921, pp. 36–38. Manner in which die-sinkers' school is conducted by Billings & Spencer Co., Hartford, Conn.

Composition and Hardening Die Blocks, James H. Herron and A. L. Wurster. Forging & Heat Treating, vol. 7, no. 1, Jan. 1921, pp. 34–36. Physical properties conferred by composition. Tempers at which die blocks are furnished.

The Design and Construction of Press Tools—I. Eng. Production, vol. 2, no. 18, Feb. 3, 1921, pp. 148–149, 4 figs. Table of allowances for punch and die for different thicknesses and materials.

DIESEL ENGINES

Armstrong-Sulzer. The Armstrong-Sulzer Marine Diesel Engine. Steamship, vol. 32, no. 379, Jan. 1921, pp. 179–182, 5 figs. Manufactured by Sir W. G. Armstrong, Whitworth & Co., England.

Marine. Marine Diesel Engine of 5,400 Shaft Horse-Power. Motorship, vol. 6, no. 2, Feb. 1921, p. 121, 2 figs. Sulzer two-cycle motor for propulsion of ocean liners.

Nordberg. Nordberg 2000 B. H. P. Two-Cycle Diesel Engine. Motorship, vol. 6, no. 2, Feb. 1921, pp. 114–118, 5 figs. Carels type four-cylinder engine with 500 b.hp. cylinder output.

Shop, Glasgow. Diesel-Engine Works in Glasgow (Dieselmaschinenfabrik in Glasgow), Karl Bernhard. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 4, Jan. 22, 1921, pp. 85–88, 12 figs. Notes on location, arrangement, design, foundation and heating of plant designed by author, work on which was begun under his superintendence in 1913, and greater part of iron construction and machinery was supplied by German firms.

Solid-Injection. New American Solid-Injection Engine. Motorship, vol. 6, no. 2, Feb. 1921, pp. 134–135, 5 figs. Small marine Diesel motor with mechanical-injection of fuel, built on Pacific coast.

DRILLING

Square Holes. Square Hole Drilling Attachment. Engineering, vol. 111, no. 2872, Jan. 14, 1921, pp. 43–44 and 46, 9 figs. Radbore head for drilling square holes from solid exactly as ordinary drilling machine drills round holes only difference in operation being that feed is put on traversing work instead of traversing drill.

DRILLING MACHINES

Pneumatic Clamps. Pneumatically Operated Clamps for Drilling Machines, J. V. Hunter. Am. Mach., vol. 54, no. 5, Feb. 3, 1921, pp. 180–181, 4 figs. Devices developed in locomotive shops of Wabash Railroad Co., Decatur, Ill.

Vertical. A New Vertical Drilling Machine. Eng. Production, vol. 2, no. 16, Jan. 20, 1921, p. 103, 2 figs. Machine is designed for high-speed twist

drills and is capable of drilling holes up to 2½ in. diameter in steel. It is manufactured by Fairbairns & Co., Leeds, England.

DROP FORGING

Industry. The Drop Forging Industry in 1920-1921, L. W. Alwyn Schmidt. Forging & Heat Treating, vol. 7, no. 1, Jan. 1921, pp. 4–7. Past year was one of general readjustment. Change in business psychology recommended. Effect of readjustment of prices on level of production still in excess of prewar volume.

DYNAMOMETERS

Heenan-Froude. The Heenan Froude Dynamometer. Flight, vol. 13, no. 4, Jan. 27, 1921, pp. 65, 2 figs. Dynamometer for testing internal-combustion engines.

E

EFFICIENCY, INDUSTRIAL

Olympia Exhibition. The "Efficiency" Exhibition at Olympia. Engineering, vol. 111, no. 2876, Feb. 11, 1921, pp. 176. Machine and methods designed to bring about personal and civic efficiency and efficiency of transport of production and of use of fuel. (To be continued.)

ELECTRIC DRIVE

Industrial Applications. The Electric Drive in Industry. Beama, vol. 8, no. 1, Jan. 1921, pp. 45–54, 15 figs. Applications of electric drive to printing presses, and machine tools.

ELECTRIC FURNACES

Fuel-Fired Furnaces vs. Relative Thermal Economy of Electric and Fuel-Fired Furnaces, E. F. Collins. Trans. Am. Soc. for Steel Treating, vol. 1, no. 4, Jan. 1921, pp. 217–227 and (discussion) pp. 227–229, 5 figs. Graphs showing relative efficiency at various temperatures, also relative cost of fuel and fuel heat losses.

Induction. High-Frequency Induction Steel-Furnace, E. F. Northrup. Chem. & Metallurgical Eng., vol. 24, no. 7, Feb. 16, 1921, pp. 309–311, 3 figs. Combination of crucible-melting flexibility with advanced practice of electric melting, manufactured by Ajax Electrothermic Corp.

Iron Foundries. Electric Furnaces in the Iron Foundry, Richard Moldenke. Iron Age, vol. 107, no. 7, Feb. 17, 1921, pp. 437–439. Costs and advantages of duplexing or electric melting of cold scrap. Control of sulphur, manganese and phosphorus. Paper before Am. Inst. Min. & Metallurgical Engrs.

Non-Ferrous Metals. Electric Furnaces for Non-Ferrous Metals. John B. C. Kershaw. Engr., vol. 131, no. 3394, Jan. 14, 1921, pp. 44 and 48–50, 7 figs. Results of tests made under three different systems of operation with two furnaces, one of ordinary brass-melting type, provided with lift-out crucible, and other of tilting type. Systems of operation were (1) continuous operation for 24 hours a day, (2) 10-hr. operation, and (3) special 10-hr. operation, in which sufficient power was maintained during night to keep furnace hot.

Oil, Gas and Coal Furnaces vs. Relative Economy of Oil, Gas, Coal and Electric Heated Furnaces, Seth A. Moulton and W. H. Lyman. Trans. Am. Soc. for Steel Treating, vol. 1, no. 4, Jan. 1921, pp. 249–270. Comparative operating costs, comparative annual production, and comparative advantages and disadvantages.

Operation. Operating Details of Electric Furnaces, Edward T. Moore. Chem. & Metallurgical Eng., vol. 24, no. 4, Jan. 26, 1921, pp. 171–176, 7 figs. Excerpt from report of electric furnace committee of Association of Iron & Steel Electrical Engineers based on questionnaire submitted to steel manufacturers operating electric furnaces.

Russ. A New Electric Arc Furnace (Ein neuer elektrischer Lichtbogenofen), E. Fr. Russ. Giesserei-Zeitung, vol. 18, no. 1, Jan. 1, 1921, pp. 3–5, 2 figs. Description of the Russ furnace, said to possess important advantages over former types; it can be used for melting copper, aluminum, other metals and alloys, as well as for the production of pig-iron casting, special steel, ferromanganese, ferrosilicon, etc.

Smelting. Electric Smelting Furnaces—I, F. Rowlinson. Beama, vol. 8, no. 1, Jan. 1921, pp. 14–22, 8 figs. Survey of developments in utilization of electric furnace for steel making.

Steel Manufacture. English and American Types of Electric Iron and Steel Furnaces Compared, John B. C. Kershaw. Foundry Trade Jl., vol. 23, nos. 229, 230 and 231, Jan. 6, 13 and 21, 1921, pp. 5–7, 2 figs., 29–30, 2 figs., and 53–55, 3 figs. Heroult, Ludlum and Rennerfelt types.

The Electric Furnace, E. T. Moore. Assn. Iron & Steel Elec. Engrs., vol. 3, no. 1, Jan. 1921, pp. 5–8. Recent applications, specially in steel manufacture.

[See also STEEL CASTINGS, Electric Melting.]

ELECTRIC LOCOMOTIVES

Comparison of Types. Economic and Constructive Aspects in the Construction of Modern Large Electric Locomotives (Wirtschaftliche u. konstruktive Gesichtspunkte im Bau neuerer Gross-Elektrolokomotiven), Alb. Laternser. Schweizerische Bauzeitung, vol. 77, no. 5, Jan. 29, 1921, pp. 49–51, 6 figs. Description of the 1C + C1 type of the Swiss Federal Railway for high-voltage single-phase current, 15,000 volt, 16⅔ periods, and the 2 C 2 type Gr. E 332 of the Italian State Railroad for 3-phase current 3000 volt, 16⅔ periods, both constructed by the Oerlikon Machine Factory; and a comparison of them with recent American types of the Gen. Elec. and Westinghouse Cos.

Design. The Application of the Electric Locomotive to Main-Line Traction on Railways, H. E. O'Brien. Jl. Instn. Elec. Engrs., vol. 58, no. 295, Sept. 1920, pp. 858–869, 9 figs. Elements of design are developed from examination of performance data of C. M. & St. P. Railway and on Italian and Swiss railways.

Freight. Freight Electric Locomotives of the Swiss Federal Railways, Constructed by Oerlikon Works (Locomotives électriques à marchandises des chemins de fer fédéraux suisses construites par les ateliers d'Oerlikon). Génie Civil, vol. 78, no. 2003, Jan. 1, 1921, pp. 1–3, 2 figs. Type 2-6-6-2; tension, 15,000 volts; maximum grade, 26 per cent; horsepower, 1700.

Operation. Train Handling with Electric Locomotives, W. S. H. Hamilton. Ry. Age, vol. 70, no. 3, Jan. 21, 1921, pp. 227–231, 5 figs. Records of operation in electrified section of C. M. & St. P. Railway.

ELECTRIC WELDING

Seam-Welding Machines. Electric Seam-Welding Machines, Alfred Gradenwitz. Am. Mach., vol. 54, no. 4, Jan. 27, 1921, pp. 128–129, 5 figs. Intermittent process designed by German firm.

Steel-Frame Buildings. Electrically Welded Steel Frame Building. Engineering, vol. 111, no. 2872, Jan. 14, 1921, pp. 55–56, 8 figs. Details of buildings constructed by welding methods in England.

EMPLOYMENT MANAGEMENT

Des Moines Employment Association. Consolidate Employment Study, H. C. Pfund. Iron Trade Rev., vol. 68, no. 4, Jan. 27, 1921, pp. 286–289 and 293, 6 figs. Association formed by employers in Des Moines, Iowa, "to promote harmony and cooperation between employer and employee," and to "encourage continuous employment."

Duties of Manager. The Employment Manager in an Engineering Works. Engineering, vol. 111, no. 2873, Jan. 21, 1921, pp. 65–66. Duties of manager. Technique of hiring men.

Railways. The Functions of a Railway Employment Service, J. C. Clark. Ry. Age, vol. 70, no. 5, Feb. 4, 1921, pp. 329–331. Methods of selecting best men and following up new employees.

Selecting Employees. Simple Tests for Selecting Office Workers, Eugene J. Benge. Indus. Management, vol. 61, no. 3, Feb. 1, 1921, pp. 91–93, 3 figs. Suggests method of devising and standardizing clerical tests.

Sizing Up the Qualities of a Man. Walter D. Scott. Can. Manufacturer, vol. 41, no. 2, Feb. 1921, pp. 39–41, 1 fig. Suggested classification of personnel qualifications. Position for which man of known character is best suited.

The Present Status of Industrial Psychotechnology with Special Regard to Foundry Practice (Der gegenwärtige Stand der industriellen Psychotechnik unter besonderer Berücksichtigung des Giesserei-gewerbes), W. Moede. Giesserei-Zeitung, vol. 18, nos. 1 and 2, Jan. 1 and 15, 1921, pp. 1–3 and 24–27, 8 figs. Brief outline of the present approved methods for the psychotechnical testing of the adaptability of industrial apprentices and discussion of their practical value.

ENAMELS

Iron and Steel. A Reading List on Vitreous Enameling on Iron and Steel, Clarence Jay West. Jl. Am. Ceramic Soc., vol. 4, no. 1, Jan. 1921, pp. 47–64. Bibliography for years 1907 to 1920.

ENGINEERS

Training of. Some Suggestions for the Training of Engineers, Amson S. J. Hall. Trans. Inst. Mar. Engrs., vol. 32, Dec. 1920, pp. 251–267 and (discussion) pp. 267–277. Combination of technical training and industrial apprenticeship.

EXECUTIVES

Duties of. How to Develop Executive Ability Through Personality, G. Sumner Small. Indus. Management, vol. 61, no. 3, Feb. 1, 1921, pp. 115–118. Study of principle underlying good organization. Means whereby executive can definitely, systematically and surely build morale in his subordinates.

EXHAUST STEAM

Utilization of. Utilization of the Exhaust Heat of a 100-Hp. Reciprocating Steam Engine (Die Abwärmeausnutzung einer 100-PSi-Kolbendampfmaschine). Elektrotechnischer Anzeiger, vol. 38, no. 11, Jan. 20, 1921, pp. 49–50. Shows with the aid of an example to what extent the exhaust steam of an engine using superheated steam can be utilized.

F

FACTORIES

Construction. Features of the New Dunlop Factory, Bernard H. Prack. Can. Manufacturer, vol. 41, no. 2, Feb. 1921, pp. 35–38, 5 figs. Construction details, layout and equipment of factory and office building.

Machine Tool Plant of New Design, F. L. Prentiss. Iron Age, vol. 107, no. 5, Feb. 3, 1921, pp. 311–316, 11 figs. Modified monitor roof instead of sawtooth type in plant of Foote-Burt Co., Cleveland.

The "Fordson" Factory—Cork, H. C. Johnson. Concrete & Constructional Eng., vol. 16, no. 1, Jan. 1921, pp. 5–13, 10 figs. Layout and structural details of concrete buildings.

FACTORY MANAGEMENT

See INDUSTRIAL MANAGEMENT.

FARM MACHINERY

Electric vs. Steam Drive. Electric Motor vs. Locomobile (Elektromotor oder Lokomobile?), R. Jacobi. Elektrotechnischer Anzeiger, vol. 38, nos. 6, 7 and 8, Jan. 12, 13 and 15, 1921, pp. 25–26, 29–30 and 33–34. Discussion of the relative economy of steam- and electrically-driven farm machinery.

FATIGUE

Industrial. Fatigue in Steel Works. Iron & Coal Trades Rev., vol. 102, no. 2758, Jan. 7, 1921, pp. 6–9. Report of Industrial Fatigue Research Board, England.

Industrial Fatigue, Charles S. Myers. Jl. Royal Soc. of Arts, vol. 69, no. 3558, Jan. 28, 1921, pp. 150–156 and (discussion) pp. 156–159. Method of measuring fatigue.

Output in Boot and Shoe Factories. Eng. & Indus. Management, vol. 5, no. 3, Jan. 20, 1921, pp. 70–72, 9 figs. Investigations carried out by Industrial Fatigue Research Board.

FERROMANGANESE

Electric-Furnace Production. The Electric Furnace for Production of Ferromanganese, E. S. Bardwell. Jl. Electricity & Western Industry, vol. 46, no. 3, Feb. 1, 1921, pp. 120–122. Method of Anaconda Copper Mining Co.

FIRE EXTINGUISHERS

Carbon Tetrachloride. Corrosive Action and Products Formed when Carbon Tetrachloride Extinguisher Liquids are Applied to Fires, A. H. Nuckolls. Nat. Fire Protection Assn., vol. 14, no. 3, Jan. 1921, pp. 221–236, 5 figs. Tests to determine corrosive action and nature of fumes resulting from application of carbon tetrachloride extinguisher liquid to fires.

FIREBRICK

Spalling. A Study of Spalling, Raymond M. Howe and Robert F. Ferguson. Jl. Am. Ceramic Soc., vol. 4, no. 1, Jan. 1921, pp. 32–46, 11 figs. Comparison of laboratory spalling tests of firebricks and behavior in service.

FOREMEN

Duties of. The New Foreman for the New Day, Fred H. Rindge, Jr. Indus. Management, vol. 61, no. 3, Feb. 1, 1921, pp. 109–111. Duties and responsibilities of foremen.

FORGING

Drop Hammers. Application of Compressed Air to Drop Hammers and Forging Presses. Forging & Heat Treating, vol. 7, no. 1, Jan. 1921, p. 27. Details of work done at U. S. Navy Yard, Norfolk, Va.

Forge Shops. Forge Plant for 75 MM Projectiles, T. W. Towler. Blast Furnace & Steel Plant, vol. 9, no. 2, Feb. 1921, pp. 168–171, 5 figs. Shop designed to turn out from 50,000 to 55,000 shell forgings daily.

Gun-Forging Plant. Armor-Plate and Gun-Forging Plant of the United States Navy, Roger M. Freeman. Forging & Heat Treating, vol. 7, no. 1, Jan. 1921, pp. 14–26, 10 figs. Description of government-built and operated naval ordnance plant at South Charleston, West Va. "H" type forge and furnace building among features of plant.

Swaging. Swaging Practice—II (Plaudereien aus der Gesenkschmiede), Paul Heinrich Schweissguth. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 5, Jan. 29, 1921, pp. 109–115, 37 figs. Deals with molding of swages. Working process is exemplified on a shrapnel double fuse. Notes on raw material, swage, swage with several parts, preliminary swaging, losses of material through waste and removing fins; determination of the preliminary swage; errors in design of swages and their prevention; useful possibilities of process.

FORGINGS

Sand-Blasting. Sand-Blasting Forgings and Sand-Blasting Versus Pickling, H. D. Gates. Forging & Heat Treating, vol. 7, no. 1, Jan. 1921, pp. 72–74, 4 figs. Comparison of costs.

FOUNDRIES

Germany. Shows Trends in German Practice, Hubert Hermanns. Foundry, vol. 49, no. 3, Feb. 1, 1921, pp. 92–93, 3 figs. Developments in molding and metallurgical practice as featured at annual meeting of German Iron Foundries Assn.

Natural-Gas Melting. Melts Gray Iron with Natural Gas. Foundry, vol. 49, no. 4, Feb. 15, 1921, pp. 139–142, 5 figs. Experience of company in melting gray iron with natural gas without regenerating either gas or air.

Steel. Combines Steel and Alloys Casting, Hubert Hermanns. Foundry, vol. 49, no. 4, Feb. 15, 1921, pp. 154–157, 6 figs. Mark Steel foundry of Wengern, Germany.

Dust Removal in. Arrangement and design of Dust-Removal Plants for Foundry Cleaning shops (Anordnung und Bemessung von Entstaubungsanlagen für Gussputzereien), W. Kaempfer. Stahl u. Eisen, vol. 41, no. 4, Jan. 27, 1921, pp. 110–113, 8 figs. Gives average values showing volumes of air to be exhausted per minute for various classes of machines, and describes different methods for the separation of dust and the different types of machines used therefor.

[See also MOLDS.]

FUELS

Oil. See OIL FUEL.

Solid, Patented. Progress in Furnace Installations for Solid Fuels (Neuerungen an Feuerungsanlagen für feste Brennstoffe), H. Pradel. Feuerungstechnik, vol. 9, no. 8, Jan. 15, 1921, pp. 65–69, 10 figs. Quarterly yearly report. Review of recent domestic and foreign patents.

Turf. A New Process of Drying Turf for Fuel in Finland. Chem. & Metallurgical Eng., vol. 24, no. 5, Feb. 2, 1921, p. 215. Raw turf in swamp is freed from all old roots and changed to thin mud, by powerful jet of water under pressure of 20 atmospheres. Mud is pumped out on drying field and spread in layers from 20 to 30 cm. in depth which are subsequently cut into bricks.

Utilization. The Work of the Committee for the Utilization of Fuels (Travaux de la commission d'utilisation des combustibles), Cornu-Thénard. Revue de Métallurgie, vol. 17, no. 11, Nov. 1920, pp. 757–764. Committee was appointed by French Ministry of Public Works. First report of Committee deals with results obtained in steel works with mixture of coal and wood in Martin furnace.

[See also COAL; LIGNITE, OIL FUEL; PULVERIZED COAL.]

FURNACES

Recuperative. A New Type of Recuperative Furnace. Foundry Trade Jl., vol. 23, no. 230, Jan. 13, 1921, pp. 32–34, 5 figs. Developed in connection with research work on glass and refractories carried on at National Physical Laboratory, England.

FURNACES, ANNEALING

Continuous. Tunnel Furnace for Continuous Annealing. Iron & Coal Trades Rev., vol. 102, no. 2759, Jan. 14, 1921, p. 49, 2 figs. Advantages claimed for tunnel type of furnace is that by gradual advance of cold material into annealing zone all calorific value of waste gases can be usefully absorbed, leaving only sufficient temperature in outlet to create necessary draft in chimney stack.

FURNACES, BOILER

Lignite-Burning. The Adaptation of Steam-Boiler Furnaces to Lignite Coals (Die Umstellung der Dampfkesselfeuerungen auf Rohbraunkohle), H. Pradel. Braunkohle, vol. 19, nos. 38, 39 and 40, Jan. 1, 8 and 15, 1921, pp. 469–472, 477–482 and 489–492, 7 figs. Impressions from the Furnace Engrs.' Convention in Berlin, Germany. Concludes with summary of author's recommendations.

Turbine. The Turbine Patent Furnace. Elec. Times, vol. 59, no. 1525, Jan. 6, 1921, p. 11, 2 figs. Designed on principle of impulse turbine. Air-trough corresponds to nozzle and fire-bars to blades of turbine.

FURNACES, ELECTRIC

See ELECTRIC FURNACES.

FURNACES, HEAT-TREATING

Electric. Recent Developments in Electric Heat-Treating Furnaces, H. O. Swoboda. Forging & Heat Treating, vol. 7, no. 1, Jan. 1921, pp. 83–85. Applications to date. Classification of electric heating furnaces as to resistor construction, resistor material, charging and operating and control. Discussion of cost of operation.

FURNACES, REVERBERATORY

Charging Method. New Method of Charging Reverberatory Furnaces, J. O. Ambler. Eng. & Min. Jl., vol. 111, no. 5, Jan. 29, 1921, p. 226, 1 fig. Experimental machine designed for charging material at practically continuous rate into furnace by mechanical means, without production of dust.

G

GAGES

Developments. Recent Developments in Gauging Apparatus. Eng. Production, vol. 2, no. 15, Jan. 13, 1921, pp. 40–44, 12 figs. Machines recently introduced by Alfred Herbert, Coventry, England, notably gear pitch and concentricity measuring machine and universal gage measuring machine.

Dial. Gauging with Dial Instruments. Engr., vol. 131, no. 3395, Jan. 21, 1921, pp. 76–77, 4 figs. Dial gages for gaging thickness, length, diameters, depth, etc.

GAGING

Limit. Limit Gauging. Jl. Instn. Mech. Engrs., No. 9, Jan. 1921, pp. 1089–1124, 25 figs. partly on 5 supp. plates. Technical considerations on formation of system of limits. Description of gage testing apparatus designed and used at National Physical Laboratory, England.

GAS ENGINES

Steel Works. The Gas Engine in Iron and Steel Works, T. B. Morley. Elecn., vol. 86, no. 2227, Jan. 21, 1921, pp. 99–102, 9 figs. Galloway tandem-cylinder engines.

Testing. The Working and Testing of a Gas Engine, Arthur G. Robson. Practical Engr., vol. 63, no. 1768, Jan. 13, 1921, pp. 20–23, 18 figs. Methods of testing.

GAS TURBINES

Elements. The Gas Turbine, B. Pochobradsky. Beama, vol. 8, no. 1, Jan. 1921, pp. 9–13. Gas turbines are classified into explosion and constant-pressure turbines. Technical elements of each of these types are studied.

French Patent. European Inventions, J. H. Blakey. Power Plant Eng., vol. 25, no. 4, Feb. 15, 1921, pp. 232–234, 4 figs. French patent for internal-combustion turbo-motor. Also patented alloy for internal combustion engine valves. Composition of alloy is nickel, 67 per cent; iron, 1 to 5 per cent; and copper, 28 to 32 per cent.

GAS WORKS

Developments. Gasworks Engineering in 1920. Engr., vol. 131, no. 3393, Jan. 7, 1921, p. 12. Survey of developments.

GASOLINE

Natural Gas. Gasoline by the Charcoal Absorption Process, G. A. Burrell, G. G. Oberfell and C. L. Voress. Chem. & Metallurgical Eng., vol. 24, no. 4, Jan. 26, 1921, pp. 156–160, 7 figs. Description of activated charcoal process for absorbing vapors from natural gas. Comparison with commercial processes; activated coconut shell charcoal; absorption and selection; steam distillation of saturated carbon; yields and quality of products.

Gasoline from Natural Gas. V—Hydrometer for Small Amounts of Gasoline, R. P. Anderson and C. E. Hinckley. Jl. Indus. & Eng. Chem., vol. 13, no. 2, Feb. 1921, pp. 144–145, 3 figs. Apparatus for rapid and fairly accurate determination of gravity of gasoline when quantity is insufficient to float usual type of hydrometer.

Peat as Source of. See PEAT, Gasoline from.

GEAR CUTTING

Hobbing Machines. Automatic Hobbing Machine. Iron Age, vol. 107, no. 4, Jan. 27, 1921, pp. 259–260, 3 figs. Machine designed for rapid production of helical and herringbone gears.

Newark No. 5 Automatic Gear-Hobbing Machine. Am. Mach., vol. 54, no. 4, Jan. 27, 1921, pp. 157–158, 1 fig. Machine designed for rapid production of helical gears.

GEARS

Grinding. The Precision Grinding of Hardened Gears. Eng. Production, vol. 2, no. 18, Feb. 3, 1921, pp. 158–161, 8 figs. Machine for grinding gears developed by Sulzer Bros., England.

Helical. See GEAR CUTTING, Hobbing Machines.

Worm. Worm Gear Design, S. Bramley-Moore. Machy. (Lond.), vol. 17, no. 434, Jan. 20, 1921, pp. 474–480, 20 figs. Study of forces acting, formulas for computing dimensions, and comparison of types of worm gears. Paper read before Instn. Automobile Engrs.

GRINDING

Centreless. Centreless Grinding. Eng. & Indus. Management, vol. 5, no. 2, Jan. 13, 1921, pp. 39–41, 3 figs. Machines which have been developed for grinding straight cylindrical work without centres.

Cylindrical, Speeds for. Work Speeds in Cylindrical Grinding. Machy. (Lond.), vol. 17, no. 434, Jan. 20, 1921, pp. 481–483. Importance of using proper speed. Fallacy of idea that the faster the rotation of work, the higher rate of production.

GRINDING MACHINES

Surface. Rotary Surface Grinding Machine. Engineering, vol. 111, no. 2874, Jan. 28, 1921, pp. 100–102, 13 figs. Constructed by Heald Machine Co., Worcester, Mass. Machine is designed for flat grinding of small articles such as can be held by magnetic chuck.

GUN METAL

Tests on. Gun-Metal, J. Arnott. Foundry Trade Jl., vol. 23, no. 229, Jan. 6, 1921, pp. 2–4, 11 figs. Suggests restriction of term "gun-metal" to ternary alloy copper-tin-zinc. Tests on metal of composition 87 per cent copper, 9 per cent tin, 3 per cent zinc and one per cent lead. Paper read before Scottish Branch Instn., British Foundrymen.

H

HACK-SAWING MACHINES

English. A New Hack Sawing Machine. Machy. (Lond.), vol. 17, no. 435, Jan. 27, 1921, p. 524, 2 figs. Designed to cut bars up to 6 in. diameter. Manufactured by Blundstone Engineering Service, Coventry, England.

HANDLING MATERIALS

Electric Power in. Application of Electrical Power to Modern Handling Plants, H. C. Widlake. Chem. Age (Lond.), vol. 4, no. 82, Jan. 8, 1921, pp. 38–40, 5 figs. Survey of developments.

Economies in Handling Materials in Industrial Plants, J. S. Tuthill. Elec. World, vol. 77, no. 4, Jan. 22, 1921, pp. 201–202. Instances of savings effected by electrically operated material handling machinery and examples of adaptation to cover varying needs.

Factories, Germany. Handling Materials in Factories (Werkstättentransporte), W. Dahlheim. Betrieb, vol. 3, no. 7, Jan. 10, 1921, pp. 187–192, 13 figs. Portable hoisting apparatus. It is claimed that the latest German types of portable elevators are far superior to those of American make. Details of a new patented one-man tipping and elevating truck lifting heavy loads from floors and raising them to proper height for loading on and in railroad cars.

Inter-Floor Transportation. Inter-Floor Transportation by the d'Humy Motoramp System, Harold F. Blanchard. Eng. World, vol. 18, no. 2, Feb. 1921, pp. 105–106, 2 figs. Staggered floor construction.

HEAT TRANSMISSION

Pipe Coverings. Emissivity of Heat from Various Surfaces, V. S. Day. Power House, vol. 14, no. 2, Jan. 20, 1921, pp. 17–23, 11 figs. Tests carried out at experiment station of University of Illinois. Heat loss was greater through asbestos paper-covered pipes than through same pipes uncovered.

HEATING

Catalytic Method. Heating by Catalysis (Le chauffage par catalyse), R. Villers. Nature (Paris), no. 2438, Dec. 25, 1920, pp. 415–416. Apparatus decomposes petroleum by catalysis in steam and carbonic acid by platinum in presence of air.

Systems, Cooling with. Method of Utilizing Heating Systems for Cooling Rooms in Summer, A. M. Feldman. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 27, no. 1, Jan. 1921, pp. 15–18, 5 figs. Patented heating and cooling apparatus comprising pipe circuit, water radiators connected at top and bottom heater and cooler and valves for cutting heater and cutting out cooler, or vice-versa, flow through system when heater is cut in being in one direction through pipe circuit for heating and in opposite direction for cooling.

HEATING, ELECTRIC

Industrial. Unusual Industrial Heating Developments, Wirt S. Scott. Elec. World, vol. 77, no. 6, Feb. 5, 1921, pp. 307–310, 6 figs. Developments of electric air heating for textile mills. Typical uses to which electric heat can be applied.

HOISTS

Mine. Hoist Designed Specially for Use in Room Work. Coal Age, vol. 19, no. 5, Feb. 3, 1921, pp. 229–230, 2 figs. Six-jaw clutch holds or frees drum from shaft. Oil supply will last three months. Special provision for jack props.

Quincy Hoist—Largest in World, Thomas Wilson. Power, vol. 53, no. 3, Jan. 18, 1921, pp. 90–95, 12 figs. Compound condensing hoist with two high-pressure and two low-pressure cylinders, 38 and 60 x 66 in., with ultimate winding capacity of 13,300 ft. of 1¼ in. rope in single layer. Hoist operates in balance, raising 20,000 lb. rock per trip at rope speed of 3,200 ft. per minute.

HOUSES, CONCRETE

England. Concrete Cottage Building. Housing at Liverpool. Concrete & Constructional Eng., vol. 16, no. 1, Jan. 1921, pp. 22–29, 9 figs. Heavy concrete walling patented by Economic Building Corporation.

HYDRAULIC JACKS

Stella. Hydraulic Jacks (Hydraulische Hebeböcke), H. Berthold. Der praktische Maschinen-Konstrukteur, vol. 54, no. 2, Jan. 13, 1921, pp. 12–15, 9 figs. Describes the Stella lifting jack constructed by the Klingelhofer-Defries Works, Ltd., Dusseldorf, Germany, consisting chiefly of a water tank equipped with a horizontal pump and a cylinder and plunger. Its advantages are pointed out.

HYDRAULIC TURBINES

Design. Tendencies in Development of Hydraulic Prime Movers, S. L. Shuffleton. Jl. Electricity & Western Industry, vol. 46, no. 3, Feb. 1, 1921, pp. 116–118, 3 figs. Capability of handling increasingly higher heads and involving increasingly large concentration of power in single units.

Installations. New Western Turbine Installations, Lewis F. Moody. Jl. Electricity & Western Industry, vol. 46, no. 3, Feb. 1, 1921, pp. 119–120, 1 fig. Survey of turbine installations now under construction by I. P. Morris Dept. of William Cramp & Sons Ship & Engine Building Co., Philadelphia.

Lubrication. Lubrication of Hydraulic Turbines. Lubrication, vol. 6, no. 11, Dec. 1920, pp. 1–8, 9 figs. Scheme for lubrication of large turbines of Niagara Falls Power Co.

Niagara Falls Power Development. The Hydraulic Turbines for Niagara Falls Power House, vol. 14, no. 2, Jan. 20, 1921, pp. 24–26, 6 figs. Each of these machines will develop 61,000 h.hp. at 187½ r.p.m. They will be coupled to 45,000-kva. vertical generators. Turbine casing weighs 110 tons.

Theory. Contribution to the Theory of High-Speed Hydraulic Turbines (Contributo alla teoria delle turbine idrauliche veloci), Giacomo Buchi. Industria, vol. 34, no. 23, Dec. 15, 1920, pp. 561–567, 17 figs. Comparative examination of design features of leading types, together with records of experiments. (To be continued.)

Wellman-Seaver-Morgan. Hydraulic Turbines for Queenston Development. Can Engr., vol. 40, no. 5, Feb. 3, 1921, pp. 185–186A, 6 figs. Casings, runners and speed rings of two Wellman-Seaver-Morgan units of 61,000 hp. capacity each.

HYDROELECTRIC PLANTS

France. Making Best Use of French Hydro Plant, Lucien Pahin. Elec. World, vol. 77, no. 7, Feb. 12, 1921, pp. 357–359. Originally designed for railroad electrification, station was utilized for war loads to alleviate loss of coal mines. How station, line and substations were changed to get maximum utilization of water.

The Great Modern Hydroelectric Plants (Les grandes distributions électriques modernes), A. Troller. Nature (Paris), no. 2433, Nov. 20, 1920, pp. 326–332, 7 figs. Tendencies in design and construction as shown in latest installations, notably hydroelectric plant at Eget in the Pyrénées.

Simplon Tunnel. The Termination of the Simplon Tunnel (L'achèvement du tunnel du Simplon), J. Boudet. Vie technique & industrielle, vol. 2, no. 16, Jan. 1921, pp. 305–314, 30 figs. Hydroelectric installation at north entrance. (Continuation of serial.)

Surge Tanks. Diaphragm Increases Surge Tank Capacity. Can. Engr., vol. 40, no. 3, Jan. 20

1921, p. 145. 2 figs. Added penstock threatened to overtop tank, but surge is throttled down by plate with small opening.

Water Control. Water Control on Hydro-Electric Systems. R. C. Denny. Power, vol. 53, no. 6, Feb. 8, 1921, pp. 208–212, 10 figs. Operating procedure for hydroelectric system of six plants utilizing combined static head of 2637 ft. Description of storage reservoirs and methods of conveying water to plants. Measurement of evaporation from reservoirs. Evaporation from one reservoir has been as high as 30 acre-feet per day.

Water Supply, Forecasting. Snow Surveying for the Forecasting of Stream Flow. J. E. Church, Jr. Eng. News-Rec., vol. 86, no. 6, Feb. 10, 1921, pp. 244–248, 2 figs. Methods, factors and results in making spring predictions of summer water supply for irrigation and power in streams fed by mountain snows.

I

IMPACT

Duration of. Researches on Duration of Impact (Recherches sur la durée du choc). Georges Moreau. Annales de Physique, vol. 14, Nov.-Dec. 1920, pp. 306–333, 2 figs. Measurements of duration of impact between ball and plain by electrical process, and empirical formula for calculating it.

INDUSTRIAL MANAGEMENT

Budget-Control System. A Budget Control System which is Producing Results. Norman G. Shidle. Automotive Industries, vol. 44, no. 6, Feb. 10, 1921, pp. 269–271, 8 figs. System of management which enables distributors and managers to know which departments are making money and which are not making money. System developed at Packard-Chicago distributors.

Expense Reduction. How to Reduce Expenses without Hurting the Business. Factory, vol. 26, no. 2, Jan. 15, 1921, pp. 167–170 and 198, 2 figs. Suggestions from executives in representative industrial works.

Inspection. The Part Inspection Plays in Good Management. Howell B. May. Factory, vol. 26, nos. 2 and 3, Jan. 15 and Feb. 1, 1921, pp. 175–179, 5 figs., and 335–339, 4 figs. Organization and operation of inspection department and selection of necessary personnel.

Instruction Sheets. Proposals for New Factory Instruction Sheets (Entwurfe neuer Betriebsblatter). Betrieb, vol. 3, no. 6, Dec. 25, 1920, pp. 44–48. Proposal of the Committee for Economic Production for an instruction sheet for the fabrication and use of screw dies.

Proposals for New Factory Instruction Sheets (Entwurfe neuer Betriebsblatter). Betrieb, vol. 3, no. 7, Jan. 10, 1921, pp. 50–51. Proposal of the Committee for Economic Production for an instruction sheet for the fabrication and use of screw dies.

Nomenclature Systems. Systematic Nomenclature and Factory Organization (Bezeichnungssystematik und Betriebsorganisation). Eduard Michel. Betrieb, vol. 3, no. 7, Jan. 10, 1921, pp. 165–177, 6 figs. It is shown that a symbol system composed of letters and numerals is superior to one consisting only of numerals, due to mnemonic simplifications. Writer advocates a comprehensive system of nomenclature and shows how, with the aid of a symbol system, concentration of energy and a considerable saving in mental and clerical work can be effected.

Organization. Organization is Death. James B. M. Clark, Jr. Indus. Management, vol. 61, no. 3, Feb. 1, 1921, pp. 141–145. Arguments against and for specialization of work.

Overhead Expense. Distributing Overhead Expense by the Machine Hour Rate Method. Christopher Haigh. Automotive Industries, vol. 44, no. 4, Jan. 27, 1921, pp. 172–177. Advantages of machine hour rate method over four other methods—man rate, man hour, sold hour, and material and labor. Paper read before Am. Gear Manufacturers' Assn.

Planning. The possibilities of Planning. E. A. Pells. Eng. & Indus. Management, vol. 5, no. 3, Jan. 20, 1921, p. 69. Functions of planning office and its place in management administration.

Production Systems. An "I am Producing More" Contest that Doubled Output. C. W. Ferguson. Factory, vol. 26, no. 3, Feb. 1, 1921, pp. 332–334, 4 figs. Experience of company of plan which gave each worker that phrase as slogan.

Economics of Workshop Practice—Mass Production (Die Wirtschaftlichkeit der Werkstattarbeit. Massenfertigung). K. Jung. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 4, Jan. 22, 1921, pp. 93–95. Author claims that present highly developed economic and industrial life calls for educated practitioners without whom no progress can be made, and points out that engineering students should be taught the value and necessity of practical work and practical education.

Economy in Single-Unit Manufacture (Wirtschaftlichkeit bei Einzelfertigung). J. Hanner. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 2, Jan. 8, 1921, pp. 29–35, 12 figs. Contrasts between mass and single-unit production; relationship between construction and production; assignment and distribution of work; measures for improvement in economical operation; superintendence; working plan and machine layout; conveyance equipment, etc.

Less Wages, or More Work? Maxwell Droke. Indus. Management, vol. 61, no. 3, Feb. 1, 1921, pp. 103–105. Writer holds that 20 per cent increase in production is safer and saner than 20 per cent decrease in wages.

Modern Production Methods—XIV. W. R. Basset. Am. Mach., vol. 54, no. 5, Feb. 3, 1921, pp. 187–191, 8 figs. Method of analyzing labor costs and their relation to final cost of manufactured article.

Why Increase Production? J. H. H. Boyd. Eng. & Indus. Management, vol. 5, no. 3, Jan. 20, 1921, pp. 73–76. Writer questions whether call for increased production is justified under present-day conditions, and further analyzes aims and objects of Higher Production Council and deals with their method of applying principle of payment by results.

Routing. Handling and Routing Large Work. Machy. (Lond.), vol. 17, no. 435, Jan. 27, 1921, pp. 501–507, 17 figs. Methods for routing of work through factory.

Routing Considered as a Function of Up-to-Date Management—IV. H. K. Hathaway. Indus. Management, vol. 61, no. 3, Feb. 1, 1921, pp. 126–134, 8 figs. Evolution of progress sheet into assembling route sheet.

Safety Departments. What is the Business of a Safety Department? Henry Landesman. Am. Mach., vol. 54, no. 7, Feb. 17, 1921, pp. 260–264. Significance of safety department in industrial plants. Advantages of safety departments.

Statistics, Compiling of. Making Statistics Talk—III. M. C. Rorty. Indus. Management, vol. 61, no. 3, Feb. 1, 1921, pp. 119–125, 9 figs. Mathematical and semi-mathematical uses of graphics.

Stock Records. Accurate Methods in Keeping Stock Records. Fred J. Huntley. Automotive Industries, vol. 44, no. 3, Jan. 20, 1921, pp. 125–128, 6 figs. System at plant of Cadillac Motor Car Co., Detroit.

Tool Repairing. "Repairing Tools—One Hour." Factory, vol. 26, no. 2, Jan. 15, 1921, pp. 172–174, 5 figs. Time records for checking idle machines and men.

[See also EFFICIENCY, INDUSTRIAL.]

INDUSTRIAL RELATIONS

Arbitrating Disputes. When You Arbitrate. Chesla C. Sherlock. Am. Mach., vol. 54, no. 4, Jan. 27, 1921, pp. 130–132. Three kinds of arbitration recognized by law.

Collective Bargaining. Tyrannous Labor Leaders, Parlor Socialists and So-Called Collective Bargaining. Henry Herbert Squire. Indus. Management, vol. 61, no. 3, Feb. 1, 1921, pp. 138–140. Protest against "tyranny of labor leaders."

Incentive Plans. How Rewards Help Workers at Their Jobs. Iron Age, vol. 107, no. 5, Feb. 3, 1921, pp. 317–320. Report of Committee on Labor Relations of Cleveland Chamber of Commerce.

Open Shop. Open Shop Wins at Golden Gate. Don Partridge. Iron Trade Rev., vol. 68, no. 6, Feb. 10, 1921, pp. 418–422, 5 figs. Works council system reported to be working satisfactorily in shipyards, commercial shops and manufacturing plants of San Francisco Bay District.

The Philosophy of the Closed Shop in Action. James A. Emery. Open Shop Rev., vol. 18, no. 1, Jan. 1921, pp. 3–24. Arguments in favor of adopting open-shop principle in U. S. Address delivered before Nat. Founders Assn.

Strikes. See STRIKES.

INDUSTRIAL TRUCKS

Railways. Electric Vehicles for Railway Purposes—II. Ry. Gaz., vol. 34, no. 3, Jan. 21, 1921, pp. 67–69, 6 figs. Device adopted by British railway companies.

INSULATORS, HEAT

Magnesia. Characteristics of 85 per cent Magnesia as a Non-Heat-Conducting Covering. Edward R. Weidlein. Heat. & Vent. Mag., vol. 18, no. 2, Feb. 1921, pp. 30–34, 11 figs. Results of tests, with curves showing most economical thickness of pipe covering for different conditions.

Conservation of Heat in Power and Heating Systems. Edward R. Weidlein. Chem. & Metallurgical Eng., vol. 24, no. 7, Feb. 16, 1921, pp. 295–300, 10 figs. Discussion of 85 per cent magnesia insulation, showing low depreciation rate under wetting and drying and high-temperature conditions. Chart for determining economical amount of insulation. Amounts of coal, heat and money saved by insulation. Paper read before Am. Inst. Chem. Engrs.

INTERCHANGEABLE MANUFACTURE

Machined Fits. An Analysis of Machined Fits. Mech. Eng., vol. 43, no. 2, Feb. 1921, pp. 132–133 and 144, 12 figs. Questionnaire being sent to manufacturers by Subcommittee on Standards and Tolerances for Manufactured Material, and sectional committee on Plain Limit Gages for General Engineering Work, a sectional committee which is working under Rules of Procedure of Am. Eng. Standards Committee and is sponsored by Am. Soc. Mech. Engrs.

INTERNAL-COMBUSTION ENGINES

Drayton. The Drayton Two-Stroke Engine. Automobile Engr., vol. 11, no. 146, Jan. 1921, pp. 14–15, 7 figs. Experimental supercharging unit.

Fatigue of. Criterion for Determining Fatigue of Internal-Combustion Engines (Au sujet de la détermination d'un critère de fatigue générale des moteurs à combustion interne). M. Dumanois. Comptes rendus des Séances de l'Académie des Sciences, vol. 172, no. 1, Jan. 3, 1921, pp. 44–46. Coefficient of general fatigue is expressed in terms of variations of temperature of inside wall of cylinder.

Fuels for. Oils for Internal Combustion Engines. J. L. Chaloner. Trans. Inst. Mar. Engrs., vol. 32, Dec. 1920, pp. 215–232, 8 figs. Comparative study of suitability of fuels used.

Testing of Oils for Internal Combustion Engines. Tom McKenzie. Trans. Inst. Mar. Engrs., vol. 32, Dec. 1920, pp. 232–247 and (discussion) pp. 247–250, 6 figs. Tests required in specifications of internal-combustion engine fuels.

Marine. Six-Cylinder Petrol or Paraffin Marine Motors. Engineering, vol. 111, no. 2876, Feb. 11, 1921, pp. 168–169, 13 figs. on supp. plate. Gleniffer motors built with 1, 2, 4 or 6 cylinders, cylinder dimensions in each case being 6 in. bore by 8 in. stroke.

[See also DIESEL ENGINES; DYNAMOMETERS; GAS ENGINES; GAS TURBINES; MOTORCYCLES, Engine for; OIL ENGINES; TRACTOR ENGINES.]

IRON

Electrolytic. Some Aspects of Electrolytic Iron. W. Albert Noyes, Jr. Thirty-Ninth General Meeting Am. Electrochemical Soc., April 21–23, 1921, 7 pp. Experimental measurement of minimum potential at which electrolytic deposition of iron can be carried out.

L

LABOR

Three-Shift vs. Two-Shift System. The Three-Shift System in the Steel Industry. Horace B. Drury. Bul. Taylor Soc., vol. 6, no. 1, Feb. 1921, pp. 2–49. Survey of conditions in some 20 American steel mills where change from two-shift to three-shift has been introduced, with notes on introduction of three-shift system almost exclusively in European and English steel works. Paper read at joint meeting of Taylor Soc., Metropolitan and Management Section of Am. Soc. of Mech. Engrs. and New York Section, Am. Inst. Elec. Engrs.

LABORATORIES

U. S. Navy. The New U. S. Naval Experimental and Research Laboratory, Havelock C. Hislop. Compressed Air Mag., vol. 26, no. 2, Feb. 1921, pp. 9973–9974. Laboratory under erection at Belleville, D. C. where civilian scientists and engineers, represented through Naval Consulting Board will have opportunity to engage in research work for benefit of navy.

LADLES

Drying. Drying 100-Ton Ladles. Alan E. Dynan. Iron Age, vol. 107, no. 6, Feb. 10, 1921, p. 394, 1 fig. Swinging-type burner using preheated tar without artificial air supply.

LATHES

Automatic. The Hartness Automatic Lathe. Am. Mach., vol. 54, no. 7, Feb. 17, 1921, pp. 273–275, 7 figs. Machine intended for large production. Head placed at angle. Groups of tools carried by two bars. All movements controlled by single camdrum.

The Hartness Automatic Lathe. Iron Age, vol. 107, no. 6, Feb. 10, 1921, p. 386, 1 fig. Designed to handle boring, turning and facing cuts in pieces under 12 in. in diameter and 6 in. in length.

Turret. Turret Lathe Applications. J. H. Moore. Can. Machy., vol. 25, no. 6, Feb. 10, 1921, pp. 38–41, 15 figs. Tooling necessary for machining engine cylinder, clutch cone, clutch cone gear, and peculiar-shaped tractor driving-axle arm.

LIGHTING

Factory. Present Day Illumination Standards. George C. Cousins. Jl. Eng. Inst. of Canada, vol. 4, no. 2, Feb. 1921, pp. 105–109, 7 figs. Relations between good lighting and increased efficiency, with tables showing results of better lighting in factory.

LIGNITE

Combustion. Combustion of Lignites and High-Moisture Fuels. T. A. Marsh. Combustion, vol. 4, no. 2, Feb. 1921, pp. 39–44, 7 figs. Methods of burning these fuels and results in their combustion. Paper read before Stoker Manufacturers' Assn.

LOCOMOTIVES

Design. Locomotives and Rolling Stock of 1920. Engr., vol. 131, no. 3393, Jan. 7, 1921, pp. 10–12 and 14, 6 figs. Survey of recent developments in design.

Electric. See ELECTRIC LOCOMOTIVES.

Feedwater Treatment. Railway Water Treatment Pays Large Returns. Paul M. LaBach. Ry. Age, vol. 70, no. 3, Jan. 21, 1921, pp. 247–248, 2 figs. Results obtained by Rock Island system.

Manufacture. Methods in a Locomotive Works. Eng. Production, vol. 2, no. 15, Jan. 13, 1921, pp. 55–64, 34 figs. Practice of Midland Railway Co., England.

Oil-Burning. Experience of a French Railway with Oil Burning Locomotives (Note sur les premiers essais a la compagnie d'orléans du chauffage des foyers de locomotives au "fuel oil"). Louis Bigourat. Revue generale des Chemins de Fer, vol. 40, no 1, Jan. 1921, pp. 9–32, 10 figs. Apparatus employed and results obtained. Comparison with coal burning locomotives.

Reconstruction. Practical Reconstruction of Old Locomotives. Ry. Age, vol. 70, no. 3, Jan. 21, 1921, pp. 237–240, 6 figs. Typical examples of reconstruction work.

Squaring Valves. A Short Cut in Squaring Locomotive Valves, William Ulrick. Ry. Mech. Engr., vol. 95, no. 2, Feb. 1921, pp. 123–124, 4 figs. Squaring valves without applying main rods and afterwards removing them.

LUBRICANTS

Tests. Flash and Fire Tests, their Importance. Lubrication, vol. 6, no. 11, Dec. 1920, pp. 9–12, 1 fig. Standard instruments for testing lubricants and methods of operation.

Viscosity. Tentative Lubricant Viscosity Progresses. Sci. Lubrication, vol. 1, no. 1, Jan. 1921, pp. 9 and 32. Tentative test for viscosity of lubricants adopted by Am. Soc. for Testing Matls.

Worm-Gear Efficiency. The Effect of Lubricants Upon Worm-Gear Efficiency, J. H. Hyde. Eng. & Indus. Management, vol. 5, no. 2, Jan. 13, 1921, pp. 46–48. Report of Lubricant & Lubrication Inquiry Committee of British Department of Scientific & Industrial Research.

LUBRICATING OILS

Carbonization. Carbonization of Lubricating Oils. Dept. of Commerce, Circular of Bur. of Standards, no. 99, Nov. 12, 1920, 44 pp. 4 figs. Nature of effects of deposits formed in internal combustion engines. It is known that term "carbon" is a misnomer, because deposits consist largely of asphaltic matter. Accounts are given of nature of petroleum oils and of theories concerning formation of deposits.

The Carbonization of Lubricating Oils in Internal-Combustion Engines, Frederic H. Garner. Petroleum Times, vol. 5, no. 107, Jan. 22, 1921, pp. 93–95. Requirements of lubricating oils which will reduce carbonization in cylinder of internal-combustion engine to minimum. (Abstract.) Paper read before Instn. Petroleum Technologists.

Cold Test. A Cold Test Apparatus for Oils, G. H. P. Lichthardt. Jl. Indus. & Eng. Chem., vol. 13, no. 2, Feb. 1921, pp. 145–146, 1 fig. Apparatus used for lubricating oils at laboratory of Southern Pacific Railroad Co.

Testing Machine. Friction and Lubrication. R. Mountford Deeley. Engr., vol. 131, no. 3395, Jan. 21, 1921, p. 78, 1 fig. Deeley's oil-testing machine. Preliminary report communicated to Lubricants & Lubrication Inquiry Committee of Dept. of Sci. & Industrial Research.

M

MACHINE CONSTRUCTION

Economics. The Relationship between Design, Construction and Economics in Machine Construction (Der Zusammenhang von Gestaltung, Fertigung und Wirtschaftlichkeit im Maschinenbau), G. Schlesinger. Betrieb, vol. 3, no. 7, Jan. 10, 1921, pp. 177–187, 10 figs. Introductory address to lecture on machine construction in the Technical Academy, Charlottenburg.

MACHINE TOOLS

Alignment. Correcting the Alignment of Machine Tools, F. Horner. Can. Machy., vol. 25, no. 4, Jan. 27, 1921, pp. 33–37, 12 figs. Methods of correcting alignment of spindles, slides, heads, cylindrical bearings, clamping devices, turrets and other parts of machine tools.

British. Notes on Improvements in British Machines. I. William Chubb. Am. Mach., vol. 54, no. 4, Jan. 27, 1921, pp. 141–145, 12 figs. Ten new types produced in last ten years. Changes in machine details. Special vs. general-purpose machines. Unusual planer drive.

Clamping Devices. Design, Fabrication and Use of Clamping Devices (Ueber Konstruktion Herstellung und Verwendung von Spanneisen), Guido Dierauer. Werkstattstechnik, vol. 15, no. 2, Jan. 15, 1921, pp. 33–39, 26 figs. Deals with various types of devices for clamping work in boring mills, lathes, milling machines, etc.

Manufacture. Tool Plant Reflects New Ideas, Dann O. Taber. Iron Trade Rev., vol. 68, no. 5, Feb. 3, 1921, pp. 344–349, 11 figs. Description of machine tool plant in Cleveland, noting arrangements of equipment and facilities for handling materials.

Performance Record. Apparatus for Recording the Performance of Machine Tools (Ueber Kontrollschreibapparate für Arbeitsleistungen an Werkzeugmaschinen), F. Breitling. Werkstattstechnik, vol. 15, no. 2, Jan. 15, 1921, pp. 43–44, 5 figs. Details of the work-recording clock originally designed and employed by Dr. Poppelreuter in his nerve clinic for wounds in the head; curves recorded with this clock are said to give an excellent presentation of the efficiency of a workman as well as of the useful scope of a machine tool. Description of Harms control apparatus for recording operations of machine tools, etc.

Repetition Work. Machining Operations on Repetition Work—Part I. Eng. Production, vol. 2, no. 16, Jan. 20, 1921, pp. 76–81, 15 figs. Examples of modern practice in construction and operation of machine tools.

Safeguards. Guarding Machine Tools. Mech. World, vol. 69, no. 1775, Jan. 7, 1921, pp. 4–5. Forms and types of safe guards. (Abstract.) Paper read before Industrial Safety Conference organized by the Home Office and British Industrial "Safety First" Association.

The Safeguarding of Machinery. Foundry Trade Jl., vol. 23, no. 230, Jan. 13, 1921, pp. 34–35. Forms and types of safeguards. (Abstract.) Paper read before Industrial Safety Conference organized by Home Office & British Industrial "Safety First" Association.

Working Speeds. Standardized Calculation of Working Speed (Einheitliche Laufzeitberechnung), A. Winkel. Werkstattstechnik, vol. 15, no. 1, Jan. 1, 1921, pp. 5–10, 10 figs. Reduction of the working-speed equation for the different machining operations to a uniform equation, correction of this equation for planing based on diagrams for planers, its use for the design of a slide rule, and the development and manipulation of described slide rule.

MALLEABLE IRON

Cupola-Melted. Experiments on Cupola Malleable. F. H. Hurren. Foundry, vol. 49, no. 4, Feb. 15, 1921, pp. 135–138, 6 figs. Comparative study of cupola melted metal and air furnace product. Paper read before Birmingham Branch, Instn. British Foundrymen.

Metallography. American Malleable Cast Iron—III, H. A. Schwartz. Iron Trade Rev., vol. 68, no. 5, Feb. 3, 1921, pp. 353–357 and 361, 9 figs. Metallography of malleable iron.

Properties. American Malleable Cast Iron—IV, H. A. Schwartz. Iron Trade Rev., vol. 68, no. 7, Feb. 17, 1921, pp. 485–488, 7 figs. Tensile properties of malleable iron.

MANGANESE STEEL

Magnetic Mechanical Analysis. The Magnetic Mechanical Analysis of Manganese Steel, Robert Hadfield and S. R. Williams and I. S. Bowen. Proc. Royal Soc., vol. 98, no. A692, Jan. 3, 1921, pp. 297–302, 3 figs. Correlation of magnetic and mechanical properties of manganese steel.

MARINE BOILERS

Return-Tube. Cylindrical Return-Tube Boilers. W. F. Carnes. Gen. Elec. Rev., vol. 24, no. 2, Feb. 1921, pp. 110–114, 7 figs. Their manufacture by Bethlehem Shipbuilding Corp.

Water-Tube. Water Tube Marine Boilers, W. M. McFarland. Gen. Elec. Rev., vol. 24, no. 2, Feb. 1921, pp. 115–119, 4 figs. Evolution and adoption of Babcock & Wilcox stationary boiler to render it suitable for use on board ship.

[See also BOILERS, WATER-TUBE.]

MEASURING INSTRUMENTS

Tolerances. Weights and Measures. Dept. of Commerce, Bur. of Standards, miscellaneous publications, no. 43, 1921, 200 pp. Specifications and tolerances of measuring instruments. Thirteenth annual conference of representatives from various states held at Bur. of Standards, Washington, D. C., May 24–27, 1920.

METALS

Calorizing. Calorizing as a Protection for Metals, Arthur V. Farr. Iron Age, vol. 107, no. 4, Jan. 27, 1921, pp. 251–253, 9 figs. General Electric Co. process of protecting methods at high temperatures. Process consists in placing material to be calorized in retort and heating in reducing atmosphere, retort being filled with mixture containing finely divided aluminum. Treatment infuses aluminum into exposed portion of metal so as to form homogeneous aluminum alloy for certain depth.

Finish. Finish of Metallic Materials, Sidney Cornell. Chem. & Metallurgical Eng., vol. 24, no. 5, Feb. 2, 1921, pp. 209–212. Quality given by heat treatment contrasted with durability and appearance. Finish of metallic materials discussed as essential detail in modern manufacturing, with brief notes on cleaning, polishing, lacquering, coatings, slushes and wrapping.

METRIC SYSTEM

Arguments Against Adoption in U. S. Metric Bugaboo Again in Congress, C. C. Stutz. Am. Industries, vol. 21, no. 7, Feb. 1921, pp. 19–21, 2 figs. Criticism of bill for adoption of Metric system in U. S. introduced into Senate. Map of the world is presented and "commanding position of the English system" is indicated.

MILLING CUTTERS

Standards. British Standards for Milling Cutters and Reamers. British Eng. Standards Assn., no. 122, July 1920, 67 pp. 46 figs. Standards for non-relieved cutters, end mills, form-relieved cutters and reamers, determined as result of conference, research and coöperation between small tool makers, machine-tool makers and users of these tools in Great Britain.

MILLING MACHINES

Manufacture. Making One Thousand Milling Machine Saddles, Donald A. Hampson. Can. Machy., vol. 25, no. 6, Feb. 10, 1921, pp. 33–37, 15 figs. Equipment necessary to produce one thousand saddles every year. Pattern work is taken up, also various machining operations, cost of machine tools and other vital points.

Profile. Profile Milling. Eng. Production, vol. 2, no. 18, Feb. 3, 1921, pp. 170–172, 8 figs. Automatic profile-milling machine.

MOLDING MACHINES

Hand-Power. Hand-Power Moulding Machine. Engineering, vol. 111, no. 2876, Feb. 11, 1921, pp. 164–166, 16 figs. Designed to be easily adjusted to take boxes and pattern plates of any size within comparatively wide range.

Suspended-Type. Inventor Installs His Own Devices. Foundry, vol. 49, no. 3, Feb. 1, 1921, pp. 98–103, 12 figs. Adaptation of molding machine through suspending it and carrying it along molding floor. Installation at foundry of Standard Malleable Iron Co., Muskegon, Mich.

MOLDS

Foundry, Drying. The Drying of Foundry Molds and Cores Through Electrically Preheated Air (Trocknung der Formen und Kerne in der Giesserei durch elektrisch vorgewärmte Luft). Zeit. für die gesamte Giessereipraxis, vol. 42, no. 4, Jan. 22, 1921, pp. 50–51. Describes electric-hot-air apparatus of the Oerlikon Machine Factory, advantages of which over other heating methods with solid fuel are pointed out.

MONEL METAL

Properties. Monel Metal—II, Adolph Bregman. Metal Industry (N. Y.), vol. 19, no. 2, Feb. 1921, pp. 64–65, 4 figs. Summary of properties, methods of melting and casting, uses, handling and working in up-to-date practice of this natural nickel alloy.

Notes on Monel Metal, Paul D. Merica. Chem. & Metallurgical Eng., vol. 24, no. 7, Feb. 16, 1921, pp. 291–294, 3 figs. Physical properties of this natural alloy, and commercial uses to which it has been adapted. Its resistance to corrosion and its strength at high temperatures are perhaps most useful properties.

MOTOR TRUCKS

American-Made. Complete Mechanical Specifications of All Makes of 1921 Gasoline Motor Trucks. Motor Age, vol. 39, no. 4, Jan. 27, 1921, pp. 90–108. Details of 527 gasoline and one steam motor truck chassis as produced by 176 American truck manufacturers.

New York Show. Observations at the New York Truck Show, P. M. Heldt. Automotive Industries, vol. 44, no. 3, Jan. 20, 1921, pp. 119–123, 13 figs. Few changes of radical nature in evidence. Influence of war designs seen in fitting of bumpers and tow hooks on many models.

Steam. Steam Waggon Construction. Eng. Production, vol. 2, no. 18, Feb. 3, 1921, pp. 162–168, 15 figs. Methods at Sentinel Waggon Works, England.

The Application of Steam Power to an Automotive Truck, Lewis L. Scott. Jl. Soc. Automotive Engrs., vol. 8, no. 2, Feb. 1921, pp. 155–160 and 162, 9 figs. Steam engine used on two-ton truck. Characteristic torque curves of 40-hp. internal combustion engine and steam engine developing same power.

Three-Point-Mounted. Three Point Chassis Mounting Feature of New Speed Truck. Automotive Industries, vol. 44, no. 5, Feb. 3, 1921, pp. 204–206, 6 figs. Midwest engine with two-bearing crankshaft and full electrical equipment is rigidly mounted on two forward points but has flexible connection with frame at rear supports. Rigid frame designed to prevent weaving of bodies.

MOTORCYCLES

Engine for. An Aluminum Motorcycle Engine. Automotive Industries, vol. 44, no. 6, Feb. 10, 1921, p. 258, 1 fig. V type with two cylinders cast together with top half of crankcase of aluminum. Translated from Motorwagen.

MOTORSHIPS

Economical Advantages. Motorships. Charles Edward Lucke. Mech. Eng., vol. 43, no. 2, Feb. 1921, pp. 140–141. Economical advantages of motorship. Construction of motorships by European shipbuilding nations and its continued adoption in U. S.

Europe. A Review of Motorship and Marine Diesel Engine Building in Europe. Mar. Eng., vol. 26, n. 1, Jan. 1921, pp. 49–54, 4 figs. During 1920 about 20 large motorships were completed and orders in hand in European yards at beginning of 1921 amount to between 180 and 190 ships, varying from vessels of 14,000 tons deadweight capacity to craft of 3,500 tons, total deadweight capacity being estimated at 1,500,000 tons.

United States. Motorship Building in the United States. Mar. Eng., vol. 26, no. 1, Jan. 1921, pp. 46–48. Nineteen motorships, totalling 143,850 deadweight tons, under construction in U. S. at beginning of 1921, total shaft horsepower of vessels amounting to 44,520.

N

NICKEL

Properties. Chemical Properties and Metallography of Nickel, Paul D. Merica. Chem. & Metallurgical Eng., vol. 24, no. 5, Feb. 2, 1921, pp. 197–200, 4 figs. Data on solubility and magnetic transformation of pure nickel; also on effect of common impurities such as carbon, oxygen, manganese, sulphur, cobalt, iron and silicon upon various physical properties.

NICKEL-CHROME STEEL

Properties. Nickel-Chrome Steels. Machy. (Lond.), vol. 17, no. 433, Jan. 13, 1921, pp. 465–467. Chart showing tensile strength of nickel-chrome oil-hardening steel.

NOZZLES

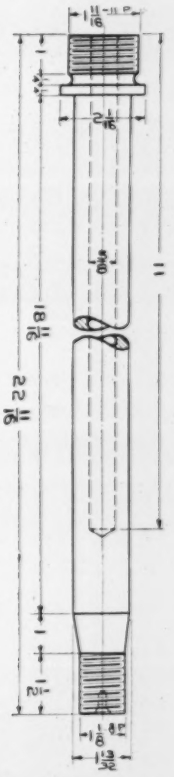
Steam, Tests of. German Tests on Steam Nozzles and Diffusors. Steam, vol. 27, no. 1, Jan. 1921, pp. 8–9, 1 fig. Experiments carried out in laboratory of machine design of Technical High School, Charlottenburg, Germany. Translated from Zeitschrift des Vereines deutscher Ingenieure.

The Best Production Methods Are the Most Economical

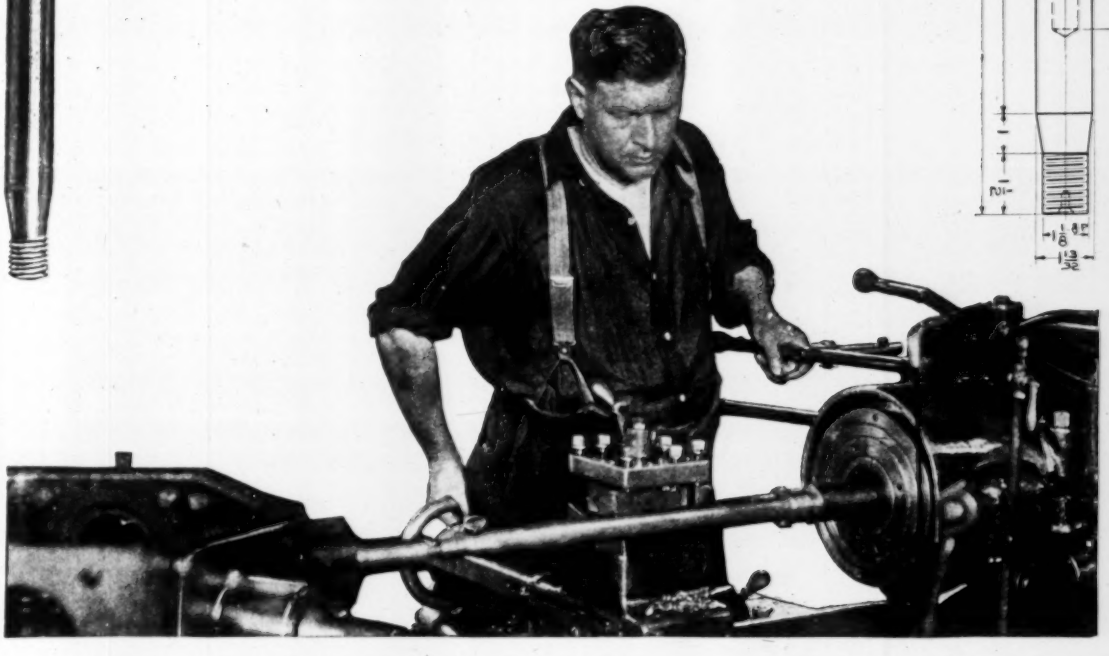
There is only one *best* method in turret lathe practice. Our Engineers are constantly studying and experimenting to reach that best method and keep our turret lathes up to their high standard.

The results of their study and experimenting are yours to apply to your production problems. Just write us and we'll send one of our engineers to consult with you. He may be able to save you considerable money by suggesting a tool or two or perhaps by re-arranging the tools you have. This is part of our service to you.

Turret Lathes from 4½" x 44"—21" Swing to 5⅝" x 4"—10" Swing.



A. W. & S. No. 3-A finishes one of these Air Brake Pump Pistons of cold rolled stock every 20 minutes in an eastern railroad shop. This is a difficult railroad job.



The Warner & Swasey Company

Cleveland, U. S. A.

NEW YORK OFFICE: Singer Building BUFFALO OFFICE: Iroquois Building BOSTON OFFICE: Oliver Building DETROIT OFFICE: Ford Building
CHICAGO OFFICE AND SHOW ROOM: 618-622 Washington Boulevard MILWAUKEE OFFICE: 209 Sycamore Building
DAYTON OFFICE: 518 Mutual Home Building INDIANAPOLIS OFFICE: 940 Lemcke Annex

Domestic Agents:

Fulton Supply Company, Atlanta, Ga.
Young & Vann Supply Company, Birmingham, Ala.
Woodward, Wight & Company, New Orleans, La.
Salt Lake Hardware Company, Salt Lake City, Utah.
Smith-Booth-Usher Company, Los Angeles, Calif.
Fred Ward & Son, San Francisco, Calif.
Portland Machinery Company, Portland, Ore.
Hallidie Machinery Company, Seattle, Wash.
Hendrie & Bolthoff Mfg. & Supply Company, Denver, Col.
Peden Iron & Steel Company, Houston, Texas.

Canadian Agents:

A. R. Williams Machinery Company, Ltd., Toronto, Winnipeg, Vancouver, St. John.
Williams & Wilson, Ltd., Montreal.

Foreign Agents:

Charles Churchill & Company, Ltd., London, Birmingham, Manchester, Bristol, Newcastle-on-Tyne, Glasgow.
Allied Machinery Company, Paris, Turin, Zurich, Barcelona, Brussels.
Wilhelm Sonesson Company, Malmo, Copenhagen, Stockholm, Gothenburg.
R. S. Stockvis en Zonen, Rotterdam.
Benson Brothers, Sydney, Melbourne, Adelaide.
Yamatake & Company, Tokyo, Osaka, Nagoya, Fukuoka, Dairen.
McLeod & Company, Calcutta.
Andersen, Meyer & Company, Ltd., Shanghai.
Brossard-Mopin & Company, Saigon, Singapore, Haiphong.

ENGINEERING INDEX (Continued)

O

OFFICE MANAGEMENT

Correspondence Filing. Some Suggestions on Office Correspondence Filing, Grant Gibson. Ry. Age, vol. 70, no. 7, Feb. 18, 1921, pp. 413–416, 5 figs. General, unit and sub-files and file book for cross reference facilitate locating letters.

OIL

Crude. Properties of Typical Crude Oils from the Eastern Producing Fields of the United States, E. W. Dean. Reports of Investigations, Dept. of Interior, Bur. of Mines, serial no. 2202, Jan. 1921, 57 pp. Specific gravity at 60 deg. fahr., sulphur percentage, water percentage, distillation at atmospheric pressure, vacuum distillation of residuum at 40 mm. absolute and Conradson carbon residue percentages.

[See also PETROLEUM.]

OIL ENGINES

Ingersoll-Rand. A New Development of the Heavy Oil Engine, F. A. McLean. Can. Machy., vol. 25, no. 3, Jan. 20, 1921, pp. 37–40, 4 figs. Principle of operation and structural details of Ingersoll-Rand, Price Rathbun type of heavy-oil engine.

Marine. 130-B. H. P. Bolnes Marine Oil Engine. Engineering, vol. 111, no. 2873, Jan. 21, 1921, pp. 70–72, 7 figs. Two-cycle hot-bulb Dutch-type engine resembling in general arrangement a steam marine engine.

Pistons. Casting and Machining Oil-Engine Pistons, Piston Rings and Cylinders, Samuel Rosswell. Am. Mach., vol. 54, no. 4, Jan. 27, 1921, pp. 137–140, 2 figs. Selection of materials. Vertical casting preferable. Heat treatment after rough-machining. Fitting piston pin. Assembling rings. Reaming vs. grinding cylinders.

Solid-Injection. Effect of Fuel Consumption on Oil-Engine Reliability, Ralph Miller. Power, vol. 53, no. 7, Feb. 15, 1921, pp. 272–273,1 fig. Diagram from solid-injection engine.

OIL FIELDS

Exploitation by Shafts and Galleries. The Exploitation of Petroleum by Shafts and Galleries (De l'exploitation du pétrole par puits et galeries), N. A. Lykiardopoulo. Revue universelle des mines, vol. 8, no. 1, Jan. 1, 1921, pp. 38–45 Methods followed in exploitation of oil at Béchelbronn, Alsace.

The Exploitation of Petroleum by Shafts and Galleries (Exploitation de pétrole par puits et galeries), Paul de Chambrier. Pamphlet published by Dunod, editor, successor to H. Dunod & E. Pinat, 47 & 49, Quai des Grands-Augustins, 1921, 106 pp. 4 figs. Economical and technical advantages over drilling methods.

OIL FUEL

Coal vs. The Use of Fuel Oil as Compared with the Firing of Coal by Means of Mechanical Stokers, F. H. Daniels. Steam, vol. 27, no. 1, Jan. 1921, pp. 5–8, 1 fig. Urges prohibiting use of oil fuel on land and restricting it to ships. Graph giving comparative fuel costs of coal and oil fuel.

Installations. Unusual Efficiencies in an Oil Fuel Installation, Joseph Poke and Frank G. Philo. Universal Engr., vol. 33, no. 1, Jan. 1921, pp. 29–33, 3 figs. Oil-burning tests results obtained at plant of Savannah Electric Co. From Stone & Webster Jl.

Locomotives. Experimental Study of Oil-Fuel Burning in Locomotive Boilers (Resultati degli esperimenti e delle prove di trazione eseguite con alcune ocomotive attrezzate per bruciare la nafta nei forni delle loro caldaie), Alessandro Mascini. Rivista tecnica delle Ferrovie Italiane, vol. 18, no. 4, Oct. 1920, pp. 117–126, 5 figs. Adoptation of locomotives to oil burning by Italian State Railways. (To be continued.)

Uses. Fuel Oil, W. A. White. North-East Coast Instn. Engrs. & Shipbuilders, Advance paper, 23 pp. 4 figs. Uses of oil fuel, particularly in ships, notes on fire precautions and appliances, with data on world oil deposits and probable resources.

OIL SHALES

Industry. A Review of the Progress of the Oil Shale Industry in 1920, Victor C. Alderson. Am. Gas Eng. Jl., vol. 114, no. 4, Jan. 22, 1921, pp. 69–71 and 79–81. Progress in utilization of oil shale.

Retorting. American vs. Scotch Methods in Retorting of Petro-Shales, J. B. Jenson. Salt Lake Min. Rev., vol. 22, no. 20, Jan. 30, 1921, pp. 17–23, 12 figs. Pumpherston and Henderson types of retorts.

Experimental Shale Oil-Retorting Plant. Chem. & Metallurgical Eng., vol. 24, no. 7, Feb. 16, 1921, pp. 312–313, 3 figs. 15-ton commercial unit installed by Shale Oil Refining Corp. at Denver, Col., using Johns eduction process.

OPEN-HEARTH FURNACES

Controlling Valve for. A New Type of Controlling-Valve for Supplying Air and Gas Mixtures to Open-Hearth Furnaces, W. H. Wharton. Iron & Steel of Canada, vol. 4, no. 1, Feb. 1921, pp. 18–20, 3 figs. Reversing valve combined with air-pressure and volume-controlling mechanism.

P

PAINTING

Spray. Recent Developments in Spray Painting, Henry A. Gardner. Paint Manufacturers' Assn. of U. S., circular no. 114, Jan. 1921, 18 pp. 20 figs. Paper read before Pennsylvania State Assn. of Master Painters.

PATTERNMAKING

Shop Organization. New England Pattern Shop is Unique, Herbert R. Simonds. Foundry, vol. 49, no. 4, Feb. 15, 1921, pp. 127–132, 13 figs. Plant is arranged as series of producing units each with its equipment complete. Progress of work is recorded by special system.

PEAT

Deposits. Classification and Formation of Peat and Related Deposits, C. C. Osbon. Jl. Am. Peat Soc., vol. 14, no. 1, Jan. 1921, pp. 37–44, 4 figs. Distinction between peat and muck. Theory of formation of deposits.

Gasoline from. Easy Money from Peat. Chem. & Metallurgical Eng., vol. 24, no. 5, Feb. 2, 1921, pp. 213–215, 1 fig. Apparatus and supertechnical process used for extracting methyl alcohol and gasoline out of peat.

Industry. News of the Industry in Foreign Countries. Jl. Am. Peat Soc., vol. 14, no. 1, Jan. 1921, pp. 31–36. British Empire, Denmark, France, Germany, Russia and Sweden.

News of the Domestic Industry. Jl. Am. Peat Soc., vol 14, no. 1, Jan. 1921, pp. 15–30. Developments of peat industry in different states.

Production in 1919. Production of Peat in 1919, K. W. Cottrell. Jl. Am. Peat Soc., vol. 14, no. 1, Jan. 1921, pp. 7–14. Total production in U. S. in 1919 was 69,197 short tons valued at $705,532.

PETROLEUM

Products, Testing. Use of the MacMichael Viscosimeter in Testing Petroleum Products, W. H. Herschel. Reports of Investigations, Bur. of Mines, Dept. of Interior, serial no. 2201, Jan. 1921, 12 pp. Conditions under which MacMichael torsion viscosimeter may be used to advantage in petroleum laboratory. Methods of operation and calibration.

PIPE LINES

Steam. Long Distance High-Pressure Steam Line. Power Plant Eng., vol. 25, no. 3, Feb. 1, 1921, pp. 157–159, 9 figs. Lines carry steam on pressure of 175 lb. per sq. in. total distance of about 3000 ft.

PLANERS

Toolroom. Gorton Toolroom Planer, J. V. Hunter. Am. Mach., vol. 54, no. 7, Feb. 17, 1921, pp. 257–259, 3 figs. Especially designed for work on dies, jigs and fixtures. Built in two sizes. Furnished with side head. Special features and specifications.

PLYWOOD

Screw Fastenings. Strength Tests of Screw Fastenings of Plywood, H. S. Grenoble. Aerial Age, vol. 12, no. 21, Jan. 3, 1921, pp. 535–536. Tables showing screws required for maximum strength, based on tests carried out at Forest Products Laboratory, Madison, Wis.

POLES, STEEL

Latticed. Calculations of Latticed Poles of Minimum Weight (Calcolo rapido dei pali a traliccio di peso minimo), Marco Semenza. Elettrotecnica, vol. 7, no. 36, Dec. 25, 1920, pp. 640–645, 3 figs. Design equations and graphs.

PORTS

New York, Reorganization of. Proposed Reorganization of the Port of New York. Ry. Age, vol. 70, no. 4, Jan. 28, 1921, pp. 269–274, 3 figs. Special automatic-electric subway recommended by New York-New Jersey Port and Harbor Development Commission.

POWER GENERATION

Gas vs. Electricity. Note on the Thermal Efficiency of the Generation and Use of Gas and Electricity, Dugald Clark. Jl. Instn. Elec. Engrs., vol 28, no. 295, Sept. 1920, pp. 765–767 and (discussion), pp. 767–779, 1 fig. Ratio of utilized heat units by electricity into utilized heat units by gas for power purposes was found in experiments to be 1.6. This ratio was 4 for heat production and 0.84 for light.

Thermal Springs. The Utilization of Thermal Springs as Source of Energy (L'emploi des eaux thermales comme source d'énergie), P. Caufourier. Génie Civil, vol. 78, no. 2, Jan. 8, 1921, pp. 37–39, 2 figs. Installation at Hammam-Meskoutine, Algiers.

POWER PLANTS

Accounting. Armour System of Power-Plant Accounting, O. A. Anderson. Power, vol. 53, no. 4, Jan. 25, 1921, pp. 128–131, 1 fig. System of records and accounting from which cost figures are deduced and analyses made of plant operations. Motive-power department has under its supervision 72,000 hp. in boilers burning nearly 900,000 tons of coal and 700,000 bbl. of oil per year.

POWER TRANSMISSION

Hydraulic. Hydraulic Transmission of Power (La transmission hydraulique), A. Raudot. Revue générale de l'Electricité, vol. 9, no. 5, Jan. 29, 1921, pp. 143–147, 4 figs. Technical study of principles of transmission of power by means of fluid, and survey of mechanisms which have been developed for this purpose. (To be continued.)

PRESSES

Feeding Devices. Littell Automatic Punch-Press Feeding Devices, J. V. Hunter. Am. Mach., vol. 54, no. 6, Feb. 10, 1921, pp. 209–212, 9 figs. Automatic feed to increase output and safeguard workmen. Construction of attachments for feeding from roll. Dial, slide and hopper feeding mechanisms.

PRESSWORK

Universal-Joint Covers. Making a Sheet-Steel Universal Joint Cover, W. A. Flumerfelt. Am. Mach., vol. 54, no. 5, Feb. 3, 1921, pp. 171–173, 9 figs. Methods of drawing and forming articles of comparatively thick sheet metal. Flanging and closing-in by means of sectional dies.

PROFIT SHARING

England. A History of Profit Sharing in the British Isles, W. Wallace. Indus. Management, vol. 61, no. 3, Feb. 1, 1921, pp. 85–89. Analysis and summary of recent report by English Ministry of Labor.

Experiences. Promoting Efficiency in Industrial Plants. Iron Age, vol. 107, no. 4, Jan. 27, 1921, p. 267. Cleveland Chamber of Commerce publishes results of survey of 600 companies and study of profit sharing in various forms.

Legislation. Profit Sharing in France (La participation ouvrière aux bénéfices de la production), Paul Razous. Génie Civil, vol. 78, no. 3, Jan. 15, 1921, pp. 59–61. Survey of legislation and practices in Government establishments. (To be continued.)

PULVERIZED COAL

Boiler Firing. Engineers Afforded Latest Information on Powdered Coal and Briquets, R. Dawson Hall. Coal Age, vol. 19, no. 1, Jan. 6, 1921, pp. 16–17. Results of boiler trials made at pulverized fuel plant, Lykens, Pa.

Some Comments on Pulverized Coal for Power Plants, Frederick A. Scheffler. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 27, no. 1, Jan. 1921, pp. 7–13, 3 figs. Typical applications of pulverized coal to Babcock & Wilcox boiler and to Stirling boiler.

Heating Furnaces. Experience with Powdered Coal for Heating Furnaces, Charles Longenecker. Forging & Heat Treating, vol. 7, no. 1, Jan. 1921, pp. 86–88, 4 figs. Advantages of powdered coal for heating and forging furnaces.

Quigley System. Pulverized Coal, Ralph H. Cridge. Elec. Times, vol. 59, no. 1526, Jan. 13, 1921, pp. 25–28, 7 figs. Quigley system of burning pulverized coal.

Tests. Actual Performance of Powdered Coal, Chas Longenecker. Blast Furnace & Steel Plant, vol. 9, no. 1, Jan. 1921, pp. 59–61. Results obtained in number of recent tests.

PUMPING PLANTS

Argentina Naval Port. The Dock Pumping Plant in the Argentine Naval Port, Puerto Militar (Die Dockpumpenanlage im argentinischen Kriegshafen Puerto Militar), H. Wiegieb. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 4, Jan. 22, 1921, pp. 89–92, 6 figs. Notes on general arrangement, main and bilge pumps, steam-boiler plant, electric and hydraulic powerhouse, operating results and comparison with other plants. Plant with all auxiliary equipment was installed by Haniel & Lueg, Düsseldorf, Germany.

PUMPS

Automatic Valves for. Investigation of Automatic Pump Valves and Their Effect on Pumping (Untersuchung selbsttätiger Pumpenventile und ihrer Einwirkung auf den Pumpengang), Ludwig Krauss. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 5, Jan. 29, 1921, pp. 116–122, 23 figs. With a view to eliminating the loud beating of pump valves and securing perfect flow conditions, writer made investigation of six modern valves under widely different working conditions, results of which show that the valve construction exercises less influence than size. Determination of values of discharge and resistance of four valves.

PUMPS, CENTRIFUGAL

Submersible. The Submersible Pump, R. C. Hill. Managing Engr., vol. 7, no. 9, Jan. 1921, pp. 165–172, 6 figs. Submersible electric motor pump used by British Admiralty Salvage Section during war.

Wilfley. The Wilfley Centrifugal Pump. Engr., vol. 131, no. 3396, Jan. 28, 1921, p. 96, 1 fig. Also in Eng., vol. 111, no. 2874, Jan. 28, 1921, p. 116, 4 figs. Impeller is formed with large hollow trunnion, through which suction water flows on its way to impeller passages.

R

RAILS

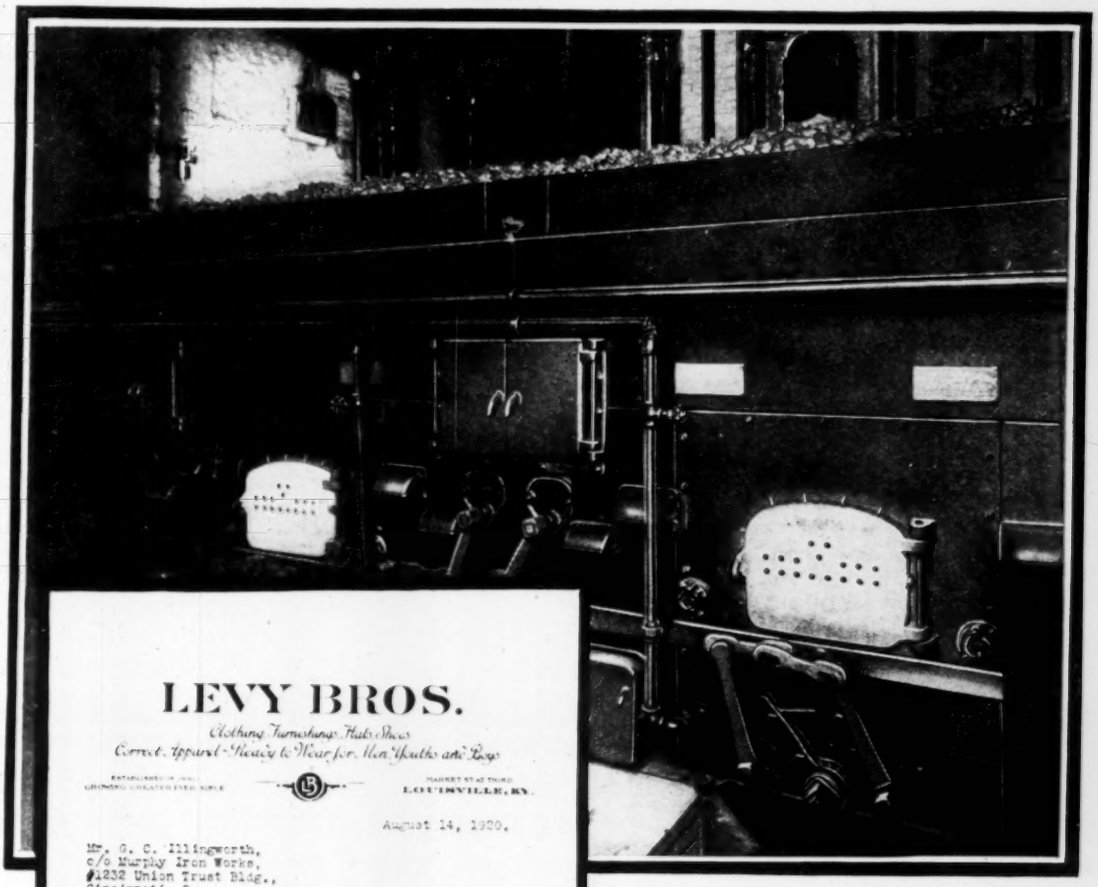
Failures. Report of Committee IV—On Rail. Bul. Am. Ry. Eng. Assn., vol. 22, no. 231, Nov. 1920, pp. 197–215, 13 figs. Report of rail failures, with statistics and conclusions as to costs. Suggestions for improvements in rail steel.

Shallow-Head vs. Deep-Head. Shallow-Head and Deep-Head Rails Compared, George H. Tinker. Ry. Maintenance Engr., vol. 17, no. 2, Feb. 1921, pp. 52–53. Service records show longer life of 14 months for shallow-heads than for deep-head rails.

RAILWAY ELECTRIFICATION

Illinois Central. The Illinois Central Electrification Project. Elec. Traction, vol. 17, no. 1, Jan. 1921, pp. 1–5, 4 figs. Ordinance regarding elec-

$35.00 Maintains 2 Stokers For 10 Years



LEVY BROS.

Clothing Furnishings Hats Shoes
Correct Apparel - Ready to Wear for Men Youths and Boys

ESTABLISHED IN 1861 GROWING GREATER EVER SINCE — MARKET AT AT THIRD LOUISVILLE, KY.

August 14, 1920.

Mr. G. C. Illingworth,
c/o Murphy Iron Works,
#1232 Union Trust Bldg.,
Cincinnati, O.

Dear Sir:

Your letter of August 12th to hand, and I am very glad to have the opportunity to express my opinion regarding the two Murphy Stokers, under 150 H. P. boilers, I have had in my charge since 1910.

During the first four years I was making steam for two engines at a rate of 13 hours per day, during the last six years for heating the building in cold weather. I have the satisfaction to say that during the entire time of ten years I lost one grate bar. I have to this date the first arches, clinker rolls and other parts of stokers in good condition.

As to the maintaining expense of your two stokers, I will say that $35. would cover everything, including fire brick and fire clay for door linings.

It always gives me pleasure to speak well for any good machine I have had during my forty years experience, and for your stokers I cannot say enough.

Hoping this record will be of some interest to you, I beg to remain,

Yours truly,

R. T. Reinsperg E.
Levy Bros.

Performance over a period of 10 years such as is indicated in the letter reproduced herewith speaks well not only for the design and construction of the

MURPHY AUTOMATIC FURNACES

but equally as well for good operation on the part of the Chief Engineer.

If you hesitate about installing stokers because you fear large repair bills, it will pay you to read carefully this letter.

To fully acquaint yourself with the design and construction of the Murphy Furnace which makes such records possible send for Catalog T-3.

"A type to meet every stoker need"

SANFORD RILEY STOKER CO.
WORCESTER, MASS.
Makers of
RILEY UNDERFEED STOKERS
BOSTON NEW YORK CINCINNATI PHILADELPHIA CHICAGO PITTSBURGH ST PAUL

TRADE MARK Rx REGISTERED

MURPHY IRON WORKS
DETROIT, MICH.
Makers of
MURPHY AUTOMATIC FURNACES
BUFFALO CLEVELAND DENVER

ENGINEERING INDEX (Continued)

trification of Chicago terminals of Illinois Central Railroad has been passed by Chicago city council and accepted by Illinois Central Railroad Co.

India. The Electrification of Indian Railways. Ry. Engr., vol. 42, nos. 492 and 493, Jan. and Feb. 1921, pp. 12–16, 7 figs. and 56–59, 7 figs. Advantages of electric locomotives as compared with steam locomotives on heavily-graded sections of North Western Railway of India.

Sweden. Electrification of the Stockholm-Saltsjobaden Railway (L'électrification du chemin de fer de Stockholm à Saltsjobaden (Suède). Revue générale de l'Electricité, vol. 9, no. 4, Jan. 22, 1921, pp. 115–117, 2 figs. Direct current of 1200 volts used.

Switzerland. Electrification Work in Switzerland. Engr., vol. 131, no. 3396, Jan. 28, 1921, pp. 95–96. Notes on projects under consideration.

RAILWAY OPERATION

Accounting. How a Railway Simplified Its Disbursements Accounting, C. O. Price. Ry. Rev., vol. 68, no. 4, Jan. 22, 1921, pp. 134–140, 7 figs. Labor-saving devices.

Train Control. Auto-Train Control Gear, Great Eastern Railway. Ry. Gaz., vol. 34, no. 1, Jan. 7, 1921, pp. 20–21, 2 figs. Explanation of regulator and brake operating and control connections.

RAILWAY SHOPS

Safety Devices. Railroad Shop Safety Devices, Frank A. Stanley. Am. Mach., vol. 54, no. 5, Feb. 3, 1921, pp. 184–186, 9 figs. Common sources of accidents on erecting floor. Use of safety screens. Saw bench and boring bit guards.

RAILWAY TIES

Reinforced-Concrete. A New Reinforced Concrete Railroad Tie. Eng. & Contracting, vol. 55, no. 7, Feb. 16, 1921, p. 164, 1 fig. Patented rail fastener is feature. Bolts are removable.

Steel. Service Tests of a Substitute Tie. Ry. Age, vol. 70, no. 3, Jan. 21, 1921, p. 252, 4 figs. "Peerless" steel tie.

Steel Sleepers on the North Eastern Railway. Ry. Engr., vol. 42, no. 493, Feb. 1921, p. 55, 3 figs. Inverted U-shaped plates supporting rails fit into channel-shaped steel ties.

RAILWAY TRACK

Concrete. Device for Holding Down Rails to Concrete Foundations. Engr., vol. 131, no. 3397, Feb. 4, 1921, pp. 131–132, 6 figs. Wooden templates fitted in conical coal.

RAILWAYS

Trans-Australian. The Trans-Australian Railway, J. J. Poynton. Ry. Gaz., vol. 34, no. 1, Jan. 7, 1921, pp. 15–19, 9 figs. Notes on construction and operation.

World Mileage. Railway Mileage of the World. Ry. Age, vol. 70, no. 6, Feb. 11, 1921, p. 367. Grand total is 706,730 miles. From Archiv für Eisenbahnwesen.

REAMERS

Ball-Joint. Tools for Locomotive Steam Pipe Joints, Frank A. Stanley. Am. Mach., vol. 54, no. 6, Feb. 10, 1921, pp. 218–220, 8 figs. Type of ball-joint reamer for steam-pipe work on locomotives.

REDUCTION GEARS

Design. New Geared Turbine Set. Power, vol. 53, no. 5, Feb. 1, 1921, p. 187, 2 figs. Turbine element is mounted directly on gear housing making one rigid frame for turbine and gear.

REFRACTORIES

Tests. Refractories and Their Relation to Furnaces. Blast Furnace & Steel Plant, vol. 9, no. 1, Jan. 1921, pp. 53–54 and 78. Tests of refractories under various conditions of slag penetration.

REFRIGERATING MACHINES

Ethyl Chloride. The Ethyl Chloride Refrigerating Machine, Charles Bishop. Cold Storage, vol. 24, no. 274, Jan. 20, 1921, pp. 5–8, 4 figs. Its design and efficiency. Paper read before Cold Storage & Ice Assn.

Rating. Rating of Household Refrigerating Machines, R. F. Massa. A.S.R.E. Jl., vol. 6, no. 6, May 1920, pp. 432–436. Survey of practices.

REFRIGERATION

Standard Unit of. Standard Unit Adopted by the Refrigerating Industry, F. E. Matthews. Power, vol. 53, no. 5, Feb. 1, 1921, pp. 184–187, 1 fig. Am. Soc. of Refrigerating Engrs. has adopted recommendations of joint committee fixing "Standard Unit of Refrigeration" as equivalent of absorption of 288,000 B.t.u. of heat.

[See also AMMONIA ABSORPTION REFRIGERATING SYSTEM, Non-Condensible Gases in.]

RESEARCH

Coördination in. Research Laboratory Adopts Modern Management, C. V. Maudlin. Indus. Management, vol. 61, no. 3, Feb. 1, 1921, pp. 98–102, 5 figs. Plan of record and control adopted at Forest Products Laboratory, U. S. Forest Service.

Government-Operated. Scientific and Engineering Work of the Government, E. B. Rosa. Mech. Eng., vol. 43, no. 2, Feb. 1921, pp. 111–118, 6 figs. Survey of government research work and its economical significance and cost.

Industrial and Scientific. A Reading List on Scientific and Industrial Research and the Service of the Chemist to Industry, Clarence Jay West. Reprint & Circular Series of Nat. Research Council, no. 9, April 1920, 45 pp. Articles on industrial and scientific research.

Industrial Research, Frank B. Jewett. Reprint and Circular Series of Nat. Research Council, no. 4, 16 pp. Urges promotion of industrial research. Paper read before Royal Can. Inst.

Research Laboratories in Industrial Establishments of the United States of America, Alfred D. Flinn, A. J. Porskievies and Ruth Cobb. Bul. Nat. Research Council, vol. 1, part 2, no. 2, March 1920, pp. 45–130. Classified list with information on staff, work and equipment.

Research in Industrial Conservation, H. E. Howe. Gas Age, vol. 47, no. 2, Jan. 25, 1921, pp. 42–44. Importance of research in securing increased production, conservation of supplies and selection of best materials and methods.

Machinery. Completes Laboratory for Research in Machinery. Iron Trade Rev., vol. 68, no. 2, Jan. 13, 1921, pp. 152–153, 4 figs. Mechanical laboratory designed for research work in machinery, installed at Nat. Lamp Works of Gen. Elec. Co., Cleveland.

Organization of. An Industrial Research Association, Arthur W. Crossley. Chem. Age (Lond.), vol. 4, no. 83, Jan. 15, 1921, pp. 73–74. Advantages of cooperative laboratory research in industry.

The Organization of Research, William Morton Wheeler. Science, vol. 53, no. 1360, Jan. 21, 1921, pp. 53–67. Deprecates organization of research because research, to be successful, must be carried out in a manner to permit full development of personality and individual initiative, manifestations which cannot take place if investigator is merely a part of an organized mechanism.

RIVETING MACHINES

Electric. The Influence of Electrotechnology on Riveting (Das Nieten unter dem Einfluss der Elektrotechnik), H. Wintermeyer. Elektrotechnischer Anzeiger, vol. 38, no. 12, Jan. 22, 1921, pp. 55–58, 4 figs. Details of modern types of electric riveting machines, electrohydraulic riveting machines, electric rivet forges, etc.

RIVETS

Electric Heaters for. Electric Rivet Heaters. Ry. Engr., vol. 42, no. 492, Jan. 1921, pp. 23–24, 1 fig. Data on power consumption.

The Lecfur Automatic Electric Rivet Heaters, Practical Engr., vol. 63, no. 1769, Jan. 20, 1921, pp. 36–38. Resistance-type furnace.

ROCK DRILLS

Electric. Electric Rock Drills for Mines and Quarries (Elektrische Bohrmaschinen im Betriebe von Bergwerken und Steinbruchen), Friedrich Ludwig. Elektrotechnischer Anzeiger, vol. 38, nos. 9 and 10, Jan. 18 and 19, 1921, pp. 39–40 and 43–44, 15 figs. Describes types of hand and column machines.

ROLLING MILLS

Efficiency of. The Economics of Roll Trains, A. Dyckerhoff. Iron Trade Rev., vol. 68, no. 4, Jan. 27, 1921, pp. 279–282, 8 figs. Closer study of roll pass design as procedure to increase overall efficiencies of rolling mills.

Electric Drive. Electrical Review Steel Industry for 1920, G. E. Stolz. Blast Furnace & Steel Plant, vol. 9, no. 1, Jan. 1921, pp. 4–5. Steam driven mills rapidly being replaced by progressive application of electricity to steel mill drives. Number of instances shown where steam equipment is being replaced.

Recent Developments in Electric Mill Drive. Blast Furnace & Steel Plant, vol. 9, no. 1, Jan. 1921, pp. 93–94. Practically all new reversing mills built during 1920 are electrically driven mills. Most interesting reversing-mill drive of year built for Tata Iron & Steel Co., at Temshedpur, India.

Plate Mills. Rolls Ship Plates on New Mill, Joseph Horton. Iron Trade Rev., vol. 68, no. 6, Feb. 10, 1921, pp. 410–412, 4 figs. English works where product is transferred from hot bed to shears by movable runout table which controls plate while its ends are being trimmed.

Rotary Side-Cutting Shear for Three-High Plate Mill. Engr., vol. 131, no. 3397, Feb. 4, 1921, pp. 124 and 129–130, 8 figs. partly on supp. plate. Mill has top and bottom rolls 36 in. diameter and middle roll of 24 in. diameter, all 9 ft. long on barrel and is designed to roll plates from $\frac{1}{8}$ in. to $1\frac{1}{2}$ in. thick up to length of 60 ft. and maximum shearing width of 8 ft. 6 in., maximum weight of finished plate being 5 tons.

The Dominion Iron and Steel Company's New Ship Plate Rolling Mill, Barton R. Shover. Blast Furnace & Steel Plant, vol. 9, no. 1, Jan. 1921, pp. 80–84, 4 figs. Electrically driven mill in which electric motors are used for practically all work in plant.

Variable-Section Shapes. Continuous Die Forming, G. R. Norton. Blast Furnace & Steel Plant, vol. 9, no. 1, Jan. 1921, pp. 104–106, 4 figs. Also in Forging & Heat Treating, vol. 7, no. 1, Jan. 1921, pp. 30–32. New process designed to roll variable section shapes at Neville Island plant of Witherow Steel Co. Products to be manufactured in alloy and special steels.

ROPES

Winding. Deformation in Winding Ropes, H. Herbst. Quarry, vol. 26, no. 287, Jan. 1921, pp. 17–21, 6 figs. Formulas for determining stresses. Translated from Glückauf.

S

SCREW MACHINES

Automatic. The Automatic Stopping of Screw Machines (Das selbsttatige Stillsetzen von Automaten), H. Bauer. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 5, Jan. 29, 1921, pp. 122–123, 11 figs. Points out desirability of automatic stopping and describes certain release devices for different makes of machines.

The "Empire" Full Automatic Screw Machine. Machy. (Lond.), vol. 17, no. 434, Jan. 20, 1921, pp. 492–493, 3 figs. English designs of automatic and pin and stud machines.

Circular Forming Tools. Design of Circular Forming Tools. Machy. (Lond.), vol. 17, no. 435, Jan. 27, 1921, pp. 517–520, 6 figs. Calculations for designing circular forming tools having top rake.

SCIENTIFIC MANAGEMENT

See INDUSTRIAL MANAGEMENT.

SEAPLANES

Design. Conditions of Flight of a Hydroplane (Etude sur les conditions d'envol de l'hydravion), Aérophile, vol. 28, nos. 23–24, Dec. 1–15, 1920, pp. 359–360, 6 figs. Technical determination of forces acting.

SHAFTS

Bending of. Theoretical Consideration of Bending in Shafts, Charles W. Good. Mech. Eng., vol. 43, no. 2, Feb. 1921, pp. 138–139. Computation of pressure distribution of loads and reactions, and effect of various distributions.

Critical Speeds. The Calculation of Critical Torsional Speeds (Beitrage zur Berechnung kritischer Torsions-Drehzahlen), Fr. Sass. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 3, Jan. 15, 1921, pp. 67–69, 9 figs. Describes method said to greatly simplify the tedious calculation of the critical torsional speed of multiple-crank engines. It is based on the combination of any number of small masses into a single equivalent mass of a given magnitude varying with the number of oscillations. Numerical tables are given for the rapid determination of the reduced length of cranked portion of shaft.

The Critical Speed of a Turbine Spindle, Richard Gardner. Engineering, vol. 111, no. 2874, Jan. 28, 1921, pp. 99–100, 1 fig. Method of obtaining formula for motor which is roughly symmetrical about its middle, taking common case of rotor formed by wheels carried on spindle, diameter of which is stepped.

Multiple-Splined. Torsional Strength of Multiple-Splined Shafts, C. W. Spicer. Jl. Soc. Automotive Engrs., vol. 8, no. 2, Feb. 1921, pp. 129–130 and 199, 4 figs. Comparative torsional tests of splined shafts and full round shafts.

SHIPBUILDING

1920. Naval Construction in 1920. Engr., vol. 131, no. 3393, Jan. 7, 1921, pp. 16–18. Statistics of shipbuilding throughout world.

The World's Mercantile Shipbuilding in 1920. Shipbuilder, vol. 24, no. 126, Feb. 1921, pp. 151–157, 1 fig. Statistics by countries.

United States. American Shipbuilding—Present and Future. Mar. Eng., vol. 26, no. 1, Jan. 1921, pp. 24–30, 2 figs. It is expected that by July 1, 1921 American merchant marine will aggregate 19,000,000 gross tons. Present tonnage is over 16,000,000 gross tons.

World Statistics. The World's Shipbuilding. Engineering, vol. 111, no. 2874, Jan. 28, 1921, pp. 102–103. Lloyd's statistics for 1920. Total production of world amounted to 7,259 ships, making 5,861,666 gross tons as compared with 2483 ships and 7,144,549 tons in 1919.

SPRING MOTORS

Manufacture. Manufacturing Spring Motors—I. Machy. (Lond.), vol. 17, no. 436, Feb. 3, 1921, pp. 556–560, 10 figs. Time-saving methods used in machining phonograph motor parts.

SPRINGS

Calculations. Derivation of Formulæ for Spring Calculations. Machy. (Lond.), vol. 17, no. 434, Jan. 20, 1921, pp. 485–488, 3 figs. Illustrations of procedure in various cases.

STANDARDS

Automotive Industry. Standards Committee Meeting. Jl. Soc. Automotive Engrs., vol. 8, no. 2, Feb. 1921, pp. 169–199, 16 figs. Proposed standards for ball bearings, electrical equipment, engine parts, etc.

STEAM

Properties. The Properties of Steam. Engineering, vol. 111, nos. 2873 and 2874, Jan. 21 and 28, 1921, pp. 63–65 and 93–94, 1 fig. Review of Callender's work. Jan. 21: Thermodynamic theory of vapor and application of vapor conclusions to steam. Jan. 28: Properties of steam near critical point. (Concluded.)

STEAM-ELECTRIC PLANTS

Enlarging. Riverside Station Enlarged by 50,000 Kilowatts. Power, vol. 53, no. 2, Jan. 11, 1921, pp. 50–57, 12 figs. Additions to steam-electric plant in Minneapolis. Features are coal and ash handling, skylight illumination of boiler and turbine rooms, all-steel turbine foundations and truck-type oil switches to facilitate their exchange or removal for inspection or repairs.

The complete electrification of its mechanical units is one of the greatest progressive movements any industry can undertake today

Electric Motors direct connected to machines is the most advanced and advantageous method of operation.

Producers' Adjustable Speed Motor direct connected to lathe.

Electricity concentrates efficiency

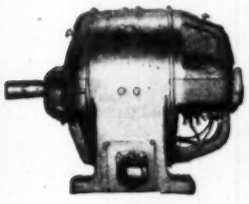
The modern machine shop affords a most striking example of what may be achieved by the electrical operation of its machines and tools.

Nothing is subordinated to power distribution—the machinery is placed in production order, and operated by direct connected electric motors with variable speed control. By this method, compact arrangement of equipment means only concentrated efficiency for all the desirable space is occupied by productive machines.

The electric system also affords a simple and profitable solution of operating trucks, conveyors, furnaces for tool repair, ventilating fans, and like equipment.

A small increase in production will more than balance the initial expense of the electric plant—there is a marked increase in production at every point where electricity is applied—consider the gain in complete electrification.

Storage Battery Truck simplifies material handling problems



Reversible Planer Motor—"Makes the chips fly faster."

Good ventilation is imperative—Riveted Frame Induction Motor direct connected to exhaust fan.

Fabroil Gear — combines durability with silent running.

General Electric Company

General Office Schenectady, N.Y.

Sales Offices in all large cities

438-528

ENGINEERING INDEX (Continued)

Germany. The Principal Defects in German Steam Plants and Their Elimination (Die hauptsächlichen Mangel unserer Dampfanlagen und ihre Beseitigung), H. Reischle. Zeit. des Bayerischen Revisions-Vereins, vol. 25, no. 1, Jan. 15, 1921, pp. 1–5. Discussion of main deficiencies in storage of fuel, and in the generation, distribution and utilization of steam. Address delivered at the Thermotechnical Convention in Munich.

Shanghai. Electrical Development in Shanghai, I. V. Robinson. Beama, vol. 8, no. 1, Jan. 1921, pp. 30–35, 3 figs. Steam-electric plant of 28,368 kw. capacity.

STEAM POWER PLANTS

Costs. Effect of Load Factor on Steam-Station Costs, Peter Junkersfeld. Mech. Eng., vol. 43, no. 2, Feb. 1921, pp. 108–110, 4 figs. Financial loss will result whenever it becomes necessary to operate power station at substantially higher or lower annual load factor than that for which station was properly designed. Load factor should be carefully considered in locating central station as well as in selection of equipment. Curves are given to show relative generating costs and boiler rating as affected by load factor, typical week-day load curves and load factors, and load factor as it occurs from day to day and month to month.

Steel Works. Modern Steam Generating Station, G. C. Emmons. Blast Furnace & Steel Plant, vol. 9, no. 1, Jan. 1921, pp. 65–78, 16 figs. Detailed account of performance of steel generating station of Republic Iron & Steel Co., Youngstown, Ohio.

STEAM TURBINES

Design. A New Graphic Method for the Calculation of Steam Turbines (Om Turbomaskiner), Matts Bäckstrom. Teknisk Tidskrift (Mekanik), vol. 50, no. 11, Nov. 10, 1920, pp. 149–166, 22 figs. 3 on 3 supp. plates. Author discusses basic formulas and principles for the calculation of turbines and explains diagram developed by him and called the temperature-drop diagram, by use of which it is possible to make calculations in a purely mechanical and simple manner.

Developments. Development of the Steam Turbine, Robert June. Blast Furnace & Steel Plant, vol. 9, no. 1, Jan. 1921, pp. 61–64, 2 figs. Development has taken place not only with respect to design of turbines, but in particular with respect to very great increase in their application to different services.

Specifications. British Standard Specification for Steam Turbines for Electrical Plant. British Eng. Standards Assn., no. 132, Oct. 1920, 8 pp. 3 figs. Technical provisions for supply of machines. Method of measuring temperature of steam.

STEEL

Aircraft Steels. See AIRCRAFT CONSTRUCTION MATERIALS, Steels.

Alloy. See ALLOY STEELS.

Bars, Weight of. Weight Table for Estimating, F. W. Salmon. Am. Mach., vol. 54, no. 5, Feb. 3, 1921, pp. 182–183, 1 fig. Table giving weight of round steel bars per linear inch.

Basic Open-Hearth. The Basic Open Hearth Melting Shop Equipment and Practice in England, George A. V. Russell. Blast Furnace & Steel Plant, vol. 9, no. 1, Jan. 1921, pp. 31 and 38–45, 4 figs. Review of mixer plant and practice, melting furnaces, metallurgical practice, handling of materials and products and layout of plant. (To be concluded.)

Bibliography. Review of Iron and Steel Literature, 1920, E. H. M'Clelland. Forging & Heat Treating, vol. 7, no. 1, Jan. 1921, pp. 8–10. Also in Blast Furnace & Steel Plant, vol. 9, no. 1, Jan. 1921, pp. 6–8. List of important publications during 1920, with a few of earlier date compiled by librarian of Carnegie Library of Pittsburgh.

Bluing and Browning. Bluing and Browning Steel Articles, Sidney Cornell. Chem. & Metallurgical Eng., vol. 24, no 7, Feb. 16, 1921, pp. 301–303. Commercial methods of producing oxidized finish on polished steel objects, including analyses of several browning solutions in use in various establishments

Gases in. Gases Obtained in Molten Steel—I, Henry D. Hibbard. Blast Furnace & Steel Plant, vol. 9, no. 1, Jan. 1921, pp. 51–53. Classification of gases and how to deal with them in order to make product sound. (To be continued.)

High-Speed. See STEEL, HIGH-SPEED.

Ingot Production. A Proposed New Ingot Mold of Steel, Robert C. Woodward. Iron Age, vol. 107, no. 4, Jan. 27, 1921, pp. 262–263, 2 figs. Cracks in ingots and their causes. Effect of heavy molds. Advantages of thin walls cooled by water.

Macrostructure. Use of Ammonium Persulphate for Revealing the Macrostructure of Iron and Steel, Henry S. Rawdon. Dept. of Commerce, Sci. Papers of Bur. of Standards, no. 402, Nov. 12, 1920, pp. 715–723, 7 figs. Method of etching.

Magnetic Reluctivity. Magnetic Reluctivity Relationship as Related to Certain Structures of a Eutectoid-Carbon Steel, C. Nusbaum, W. L. Cheney and H. Scott. Dept. of Commerce, Sci. Papers, Bur. of Standards, no. 404, Nov. 26, 1920, pp. 739–757, 7 figs. Changes in physical properties resulting from thermal treatment were studied for one per cent carbon steel and it was found that very rapid rise of maximum and residual induction and even more pronounced decrease in coercive force occur between drawing temperatures of 150 and 250 deg. cent. Such changes very likely mark transformation from martensite to troostite.

Manganese. See MANGANESE STEEL.

Metallography. Metallographic Methods for Determining the Nature of Non-Metallic Inclusions in Steel and Cast Iron (Methodes métallographiques pour déterminer la nature des inclusions non métalliques contenues dans l'acier, le fer et la fonte), M. M. Matveieff. Revue de Métallurgie, vol. 17, no. 11, Nov. 1920, pp. 736–752, 25 figs. Comparative value of different etching reagents.

Microstructure. Notes on the Microstructure of Annealed Soft Steel, with Special Reference to Phosphorus in Tin Plate, Geo. F. Comstock. Forging & Heat Treating, vol. 7, no. 1, Jan. 1921, pp. 60–63, 16 figs. Interpretation of photomicrograph.

Nickel-Chrome. See NICKEL-CHROME STEEL.

Phosphorus and Sulphur. Effect of Phosphorus and Sulphur on Steel, E. W. Rettew and L. A. Lanning. Trans Am. Soc. for Steel Treating, vol. 1, no. 4, Jan. 1921, pp. 247–249. Phosphorus increases tensile strength without decreasing ductility and increases hardness without lowering electric conductivity. Sulphur increases susceptibility to corrosion.

Tool. High Carbon Open-Hearth Steel Versus Crucible Tool Steel in the Manufacture of Miscellaneous Tools, George Porteous. Trans. Am. Soc. for Steel Treating, vol. 1, no. 4, Jan. 1921, pp. 238–244, 5 figs. Open-hearth high-carbon steel with proper heat treatment gives as good results as are given by higher grade and more expensive tool steel.

Uranium. See ALLOY STEELS, Uranium Steel.

Wrought Iron vs. Single Refined Wrought Iron Versus Steel, V. E. Hillman. Forging & Heat Treating, vol. 7, no. 1, Jan. 1921, pp. 63–65, 8 figs. Argument in favor of feasibility of substituting soft basic open-hearth steel for single-refined wrought iron.

STEEL CASTINGS

Annealing. Annealing Steel Castings with Fuel Oil, R. R. Hillman. Iron Age, vol. 107, no. 4, Jan. 27, 1921, pp. 247–249, 1 fig. Design and operation of new furnace in plant of Atlas Steel Casting Co. Blast for combustion heated by outgoing gases.

Converter Process of Production. The Small Converter Process and Its Importance in the Production of Steel Casting (Die Kleinbessemerei und ihre Bedeutung fur die Stahlgusserzeugung), R. Schmidt. Zeit. fur die gesamte Giessereipraxis, vol. 41, nos. 51 and 52, Dec. 18 and 25, 1920, pp. 661–662 and 677–678, and vol. 42, nos. 2 and 3, Jan. 8 and 15, 1921, pp. 17–18 and 35–36. Writer relates his experiences with process in his capacity as inspection engineer for artillery workshops.

Electric Melting. Electricity Shop's Sole Heat Source, H. E. Diller. Foundry, vol. 49, no. 3, Feb. 1, 1921, pp. 87–91, 8 figs. Equipment installed at foundry of Emery Steel Castings Co., Baltimore, which specializes in light castings of intricate design.

Molding Sand for. Sand Plays Part in Poor Castings, R. J. Doty. Foundry, vol. 49, no. 3, Feb. 1, 1921, pp. 95–97. Clean, smooth steel castings are dependent upon facing and heap sand used. Close heap sand causes blows. Ten parts heap sand mixed with one part new sand in facing. Paper read before Am. Foundrymen's Assn.

Specifications. Meet Steel Castings Specifications, E. R. Young. Foundry, vol. 49, no. 4, Feb. 15, 1921, pp. 152–153. Work done under U. S. Ordinance Departments specifications. Table showing effect of various amounts of titanium on physical properties. Paper read before Am. Foundrymen's Assn.

Strength. Steel Castings of High Strength and Toughness—II, Federico Giolitti. Chem. & Metallurgical Eng., vol. 24, no. 4, Jan. 26, 1921, pp. 161–165, 15 figs. Data on improvement to be expected after properly heat-treating steel castings, with illustrative tests on strong, tough castings which have replaced forgings on gun mounts.

STEEL, HEAT TREATMENT OF

Electric. Electric Heat Treating at Emery Steel Casting Company, F. W. Brooke and Geo. P. Mills. Forging & Heat Treating, vol. 7, no. 1, Jan. 1921, pp. 45–47, 5 figs. Electrically heated core oven and annealing furnace for small intricate castings. High operating efficiency and low initial cost claimed for electric process.

Heat-Treating Department. Constructing a Heat Treating Department, L. C. Dunn. Forging & Heat Treating, vol. 7, no. 1, Jan. 1921, pp. 40–45, 7 figs. Commercial heat-treating department built by Montgomery Chemical Works, Detroit.

Hump Furnaces. Recent Installations of Hump Furnaces, G. W. Tall, Jr. Forging & Heat Treating, vol. 7, no. 1, Jan. 1921, pp. 48–51, 12 figs. Hump method and drawing furnaces as it is proposed to install them at new plant of Cadillac Motor Car Co., Detroit, Mich.

Methods. Metallography and Heat Treating of Steels, Wm. J. Merten. Blast Furnace & Steel Plant, vol. 9, no. 1, Jan. 1921, pp. 114–118, 15 figs. Review of various types of heat treatment. Photomicrographs.

STEEL, HIGH-SPEED

Manufacture. High-Speed Steel Manufacture in Sheffield, Paul M. Tyler. Iron Age, vol. 107, no. 6, Feb. 10, 1921, pp. 371–374. Great expansion in war time. Present practice, costs, prices and raw material sources. Wages much below American.

STEEL INDUSTRY

Germany. Development of the Steel Industry During the War in Germany—II, Hubertt Hermanns. Blast Furnace & Steel Plant, vol. 9, no. 2, Feb. 1921, pp. 146–150, 2 figs. Utilization of basic open-hearth slag.

STEEL MANUFACTURE

Basic Open-Hearth Process. Basic Open-Hearth Melting Shop Equipment and Practice, G. A. V. Russell. Iron & Coal Trades Rev., vol. 102, nos. 2759 and 2761, Jan. 14 and 28, 1921, pp. 37–39, 3 figs., and 122–124, 3 figs. Rapid growth of basic open hearth process is attributed to its suitability for dealing with pig irons of widely varying composition. Comparative developments of mixer practice in England and other countries. Metallurgical practice at representative British steel works. (To be continued.)

STEEL WORKS

Power Plants. Recent Developments in Steel Works Power Plants, W. N. Flangaan. Blast Furnace & Steel Plant, vol. 9, no. 1, Jan. 1921, pp. 56–59, 1 fig. Steps taken to reduce labor and consumption of coal.

[See also ROLLING MILLS.]

STOKERS

Automatic. Developments in the Design of Automatic Mechanical Stokers (Note sur quelques perfectionnements des foyers à grille chaine tournante), A. Lambotte. Société Belge des Electriciens, vol. 34, Nov.-Dec. 1920, pp. 253–260, 3 figs. Use of automatic stokers for burning low-grade coals.

Reconstruction. Remodeling Stokers and Furnaces Adds to Capacity, T. A. Marsh. Elec. World, vol. 77, no. 4, Jan. 22, 1921, pp. 196–197, 4 figs. Boiler ratings raised 39 per cent by enlarging grate areas and improving arch design. Practical method at minimum cost.

STRIKES

Causes. Strikes—How to Avoid Them, William Leavitt Stoddard. Indus. Management, vol. 61, no. 3, Feb. 1, 1921, pp. 77–84. Most important single cause of strikes is lack of common understanding between employer and employee, "generally due to the fact that employer and employee do not get together as they could and should." Secret of avoiding strikes lies in personal contact.

SUBSTATIONS

Automatic. Automatic Substations (Sottostazioni automatiche), I. Primetti. Elettrotecnica, vol. 7, no. 35, Dec. 15, 1920, pp. 622–625, 3 figs. European and American developments.

SUPERHEATERS

Marine. Steam Superheaters in Merchant Ships, H. B. Oatley. Gen. Elec. Rev., vol. 24, no. 2, Feb. 1921, pp. 121–123, 5 figs. Classification into live-gas and waste-gas types. Location of superheater equipment.

The Sugden Uptake-Type of Superheater for Scotch Marine Boilers. Engineering, vol. 111, no. 2872, Jan. 14, 1921, pp. 37–40, 16 figs. Superheater is accommodated wholly in smokebox and Howden air heater is fitted at base of uptake.

T

TERMINALS, MARINE

Improvements. Marine Terminals and Port Facilities, Floyd T. Smith. Mar. Eng., vol. 26, no. 1, Jan. 1921, pp. 66–71, 8 figs. Survey of port developments contemplated.

TERMINALS, RAILWAY

Toronto. Mechanical and Electrical Equipment of the Toronto Union Station, Walter J. Armstrong. Jl. Eng. Inst. of Canada, vol. 4, no. 2, Feb. 1921, pp. 87–97, 7 figs. General survey of mechanical and electrical equipment for new Union Station, including heating and ventilation, lighting, elevators, power equipment, fire-alarm systems, etc.

TESTING MACHINES

Developments. Recent Developments in Testing Machines, Thorsten Y. Olsen. Forging & Heat Treating, vol. 7, no. 1, Jan 1921, pp. 66–69, 12 figs. Survey of developments during last 50 years.

Manufacture. The Manufacture of Weighing and Testing Machines. Eng. Production, vol. 2, no. 16, Jan. 20, 1921, pp. 91–95, 11 figs. Methods at works of W. and T. Avery, England.

Universal. The Bradley-Richards 30-Ton Universal Testing Machine. Practical Engr., vol. 63, no. 1768, Jan. 13, 1921, pp. 28–30, 2 figs. Testing force is obtained by fluid pressure, working fluid being mineral oil

TESTS AND TESTING

Stamping Tests. Stamping Tests of Thin Sheets (Essai, à l'emboutissage, des tôles minees), Charles Frémont. Comptes rendus des Séances de l'Académie des Sciences, vol. 172, no. 3, Jan. 17, 1921, pp. 146–148, 2 figs. Value of stamping tests for determining elastic properties of material.

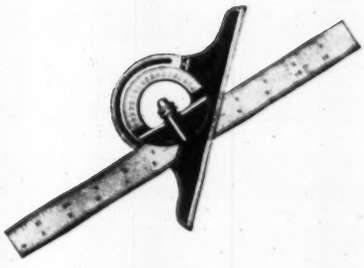
Stop-Watch Uses. The Limitations of the Stop Watch as a Precision Instrument, A. L. Ellis. Jl. Am. Inst. Elec. Engrs., vol. 40, no. 2, Feb. 1921, pp. 104–112, 22 figs. Accuracy to be expected in time measurements by stop watch in scientific and engineering testing.

Tenacity. The Tenacity of Materials as Basis for Calculating Steel Constructions, Especially Bridges

Have You the Missing Tool?

For laying out work any Starrett dealer can supply you with as many as twelve Bevel Protractors, three Universal Bevel Protractors, or twelve Combination Sets, which include slide, square, center and protractor heads.

Six of the Bevel Protractors are made with the head extending over both sides of the blade. Of the three Universal Protractors, two are equipped with verniers.



Have you the tool this man should be using? Look it up in Catalog No. 22 "LD"

THE L. S. STARRETT COMPANY
The World's Greatest Toolmakers
Manufacturers of Hack Saws Unexcelled
ATHOL, MASS.

Use Starrett Tools